REVIEW OF FACULTY OF ENGINEERING

Analecta Technica Szegedinensia

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UNIVERSITAS SCIENTIARUM SZEGEDIENSIS
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USING COMPUTER GRAPHICS AND COMPUTER AIDED DESIGN METHODS INTO THE CONCEPTION OF THE BOLTED CONNECTIONS

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ABSTRACT

As a result of the application of the tools provided by the digital computer and interactive computer graphics, the reality of modern mechanical engineering design in the current industrial environment is changing. At the same time, customer expectations for the quality and durability of products are continuously increasing and the constraints of cost and lead-time are becoming more and more compelling.

This situation poses new challenges in the product-development process and introducing, also, new demands in the preparing process of tomorrow's engineers and scientists, in order to a proper integration in the engineering curricula of the computer aided design, which eliminates the need for costly changes, unnecessary delays or unsatisfactory design releases.

Along these lines, the objective of the paper is to present some of our experimented ways of integrating the CAD basics concepts with the use of a specifically design and analysis software. These techniques, very efficient in the instruction/education period of the futures engineers in mechanical domain, are exemplified with a design software dedicated for bolted joints, which have to transmit static, dynamic and thermal working loads.

Keywords:
conception, computer grafics, computer aided design, pre-stressed bolted connections

1. INTRODUCTION AND CONTEXT

Despite a variety of new joining techniques, nuts and bolts still play an important role for many industries.

One of the most important causes of bolted joint failure is incorrect prestress, though more attention is generally given to the torque value when tightening the nut. In spite of several well known measuring methods, prestress is still difficult to check. While the designer knows the forces on machine parts or flanges, he often does not account for losses through friction and material settling when parts are repaired.

On other hand, the most currently used methods of bolted joints design induce often important differences between the necessary and the effective characteristics of the final product. The different phases passed for a joint in order to satisfy the desired function will induce important drifts. These results, generally, from an insufficient knowledge of the bolted joint and of the effects of certain deviations on the reliability in service. In different phases of the implementation, the deviations arise from oversizing in the design phase, surface finish by manufacturing, tightening facilities by assembly, etc.

The ignorance of the repercussions of certain deviations on the quality of the product leads to the tendency of employing a safer, but too severe projecting procedure. If the quality of the products requires it, very close tolerances on the implemented controls will ensure the

reliability of the assembly by rejecting bad parts. In the case of high performance joints, these methods of manufacturing are severely penalized because of their lack of flexibility.
Calculation only applies by considering the loads acting upon a single fastener. When a joint comprises several fasteners, a mechanical analysis of the external loadings will have to be carried out beforehand, in order to define the resultant loads related to the calculated fastener (axial load, transverse load, bending moment).
The Cetim-Cobra calculation method applies to bolted joints which have to transmit static, dynamic and/or thermal working loads. It determines the optimal preload to fulfill the non-opening and/or non-sliding of the clamped parts. These joints necessarily use high duty fasteners (screws, bolts, studs or threaded rods) and a controlled tightening.

2. THE CASE STUDY. METHODS AND PROCEDURES

The suggested methods and procedures result from a complete calculation of the bolted joint. In the most complex case, the algorithms of the proposed software comprise different calculations and include multistandards databases (ISO, EN, BS, DIN, AFNOR, etc.) and wizards. These allow an easier data entry for the standard dimensions (as bolt, nut or washer) and the mechanical characteristics of materials.
Considering the initial data of the joint: geometry, mechanical and/or thermal loadings, material characteristics, the software determines the necessary data for the design and assembly, which would insure an optimal use of the joint. It checks that the bolt and clamped parts can sustain the tightening loads and can work static, dynamic and/or thermal loadings. The Cetim-Cobra calculation method comprises several essential modules such as the calculation of the fastener and clamped parts resilience (or stiffness) and the thread stripping behavior. Regarding the software functionalities for a bolted joint calculation, Cetim-Cobra can take up to 90 different parameters into account.
- Calculation parameters: The mechanical and/or thermal loadings; The geometrical and mechanical characteristics of the fastener (screw, bolt, stud, threaded rod or nut); The geometrical and mechanical characteristics of the clamped parts (washers included); The tightening conditions: tightening method, friction coefficients, preload limits.
- Calculation results: The resilience (or the stiffness) of the fastener and clamped parts; The dynamic stress in the thread of the fastener (to prevent fatigue failure); The minimum required preload ensuring the non-opening and/or non-sliding of the clamped parts in work, i.e. to prevent joint failure; The maximum allowable preload which takes into account the limit of all the assembled material characteristics; The maximum stress in the fastener; The minimum strength of the fastener, when the property class is not defined; The fastener elongation after tightening (to prevent loosening); The maximum stresses in the spring washers; The pressure at the joint faces (to prevent loosening); The minimum and recommended thread lengths of engagement in the case of a tapped part (to prevent thread stripping); The optimal tightening setting (torque, angle or tension) which takes into account the results above and a possibly prevailing torque.
- The facilities for the user are: In-line help with figures, integrated theoretical handbook and technical documentation, knowledgebase, external references; Evolutionary and standard databases: material characteristics, component dimensions (integrated manager); 5 wizards; Check of the data conformity before any calculation; Quick description of the parts by using basic sub-shapes; 3D or cross section view of the joint after modelling; Compressed volume or

compressed area at the joint faces view after calculation; Result analysis; Calculation report printing in English or in French; Calculation report exportation in a word-processing software (via a RTF file).
Cetim-Cobra is in conformity with a linear model in the case of cylindrical clamped parts with a uniform cross section. The other geometrical cases are calculated by extrapolating what has been validated by finite elements analysis.

3. THE BASES OF THE CALCULATION IN *Cetim-Cobra* SOFTWARE

In a pre-stressed joint, [2], the preload F_o is an axial tensile stress in the bolt (Figure 1, 2, 3) whereas the parts are compressed.

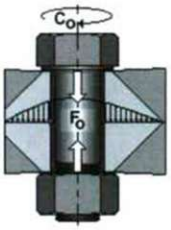


Fig.1.
Bolt axial tensile stress

Fig. 2.
Bolted joint calculation model

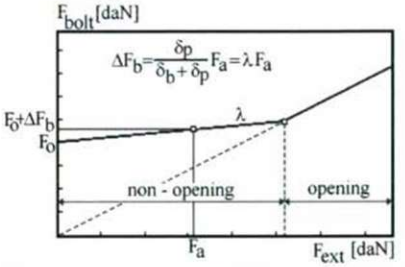


Fig. 3. Relationship between the load in the bolt and the load applied to the clamped parts

In principle, the bolted joint is modeled using springs, in a rather simple way (Figure 2): the spring of resilience δ_b simulates the bolt, and the spring of resilience δ_p simulates the clamped parts. The joint is tightened with an initial preload F_o. A positive external load F_a increases the tension in the bolt of ΔF_b. This tension is only a fraction of F_a in the proportion: $\Delta F_b = \lambda F_a$. The behavior of this model, [2], is exemplified in Figure 3.
To prevent any cracking (at the fatigue resistance of a bolt for example) the designer will have to size the joint in order to remain in the non-opening area. Concerning the control of the tightening conditions, in practice the preload F_o will vary in a certain range, whatever the tightening method used, considering the tightening tool accuracy and manufacturing tolerances of the parts. Determining this range with precision is very important, as its minimum value must ensure that the parts remain in contact regardless of the working loads, and its maximum value must not exceed the mechanical characteristics of the materials in contact.

4. EXAMPLE OF A STUDIED JOINT

A typical example of an industrial application is the pre-stressed bolted joint - Prismatic flange, [2].
We consider such a bolted joint, with the configuration of the studied part of the connection presented in Fig. 4.
The joint configuration result is produced with the *CONFIGURATION* module, and displays the data previously entered in the *"New project file"* wizard.

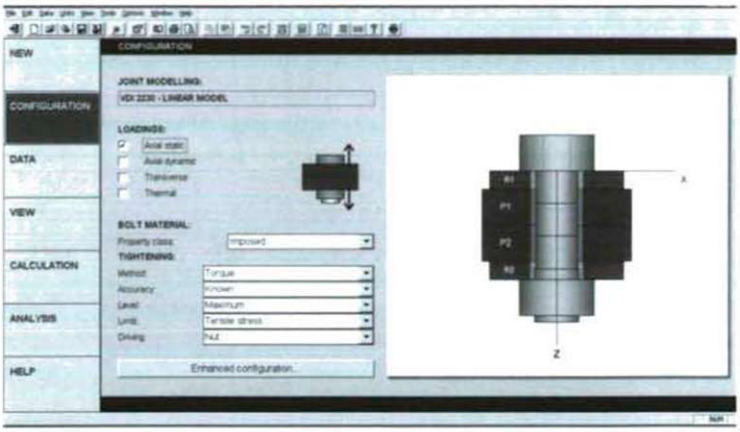


Figure. 4.: Pre-stressed bolted joint - Prismatic flange in the CONFIGURATION module

In order to create a project file in the CETIM-Cobra software, we must declare (and/or select from a predefined list) the following data: the calculation method (for example, if loadings are known, one can demand a complete calculation of the joint behavior in service); the fastener characteristics; the tightening components; the clamped parts (the parts compressed during the tightening); the external mechanical loadings.

Generally, the material design is automatically obtained when using a *Material database* either from the modulus of elasticity field, or the yield compressive strength field.

The material used for the joint parts are made of heat treated steel, with the following mechanical characteristics:

modulus of elasticity at 20°C, 210000N/mm^2; yield compressive strength, 900 N/mm^2; yield shear strength, 420N/mm^2.

In the *DATA* module, the input data pages are classified by considering the type of the following parameters: Loadings; Description of the fastener; Description of each part of the joint; Tightening conditions.

In the studied joint we have considered the following mechanical loadings: Maximum axial external force, $F_{a\ max}$ = 1000 N; Excentration x_F = 32.50mm; Loaded parts: Flange1 and Flage2; Load introduction factor, β=0.70.

The constituent and the components parts of the joint, respectively Bolt, Washer 1, Washer 2, Flange 1, Flange 2, Nut, have been configured in the *DATA* module.

As example, the configuration of the bolt and the modelling of its components are illustrated in Figure 5.

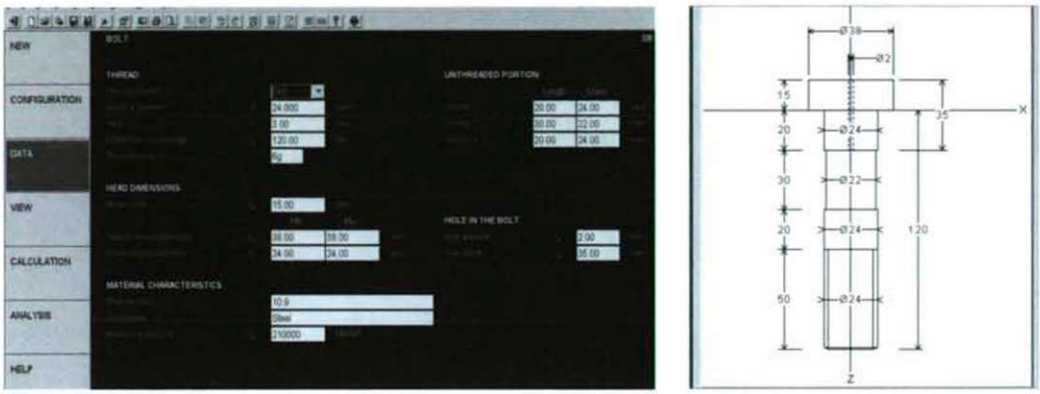
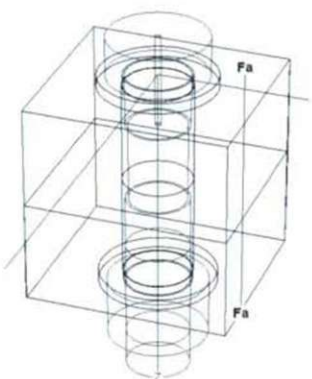
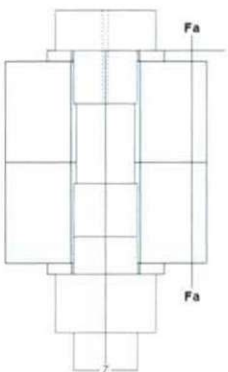


Figure 5. Bolt configuration and modelling of its components in the DATA module

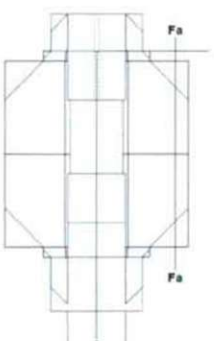
The modelling of the joint is displayed in the *VIEW* module. By click on the specific button, the following views options are available: *3DView, 2DCrossSection, Compressed Volume, Pressure Ares* (Figure 6a -Figure 6d).



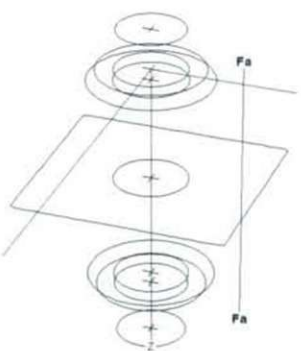
a. 3D View



b. Cross Section View



c. Compressed Volume view



d. Pressure Ares view

Figure.6. Modelling of the entire joint displayed in the VIEW module:

a - 3D View; b - 2D Cross Section; c - Compressed Volume; d - Pressure Ares

This allows us to check if the relative parts positions, as well as the position of the parts in comparison with the axial external load F_a, respectively the position of the fastener inside the parts (incompatible diameters, emerging holes, etc.), are correct.
The calculation of the joint, preceded by a data check, is conducted in the *CALCULATION* module, Figure 7.
In case warnings, faults or errors are detected, a dialog box is automatically open and we can carry out a correction by an interactive "coming back", directly in the corresponding input page of the *DATA* module.

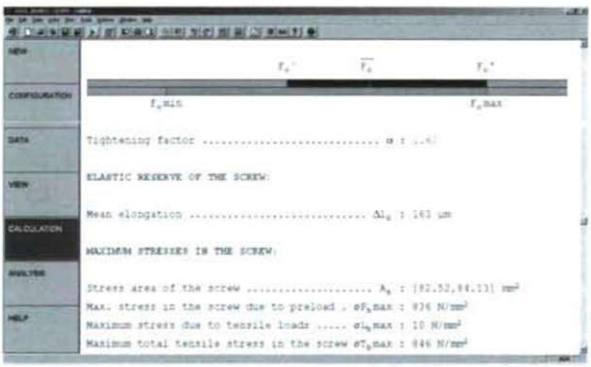


Figure 7. Results examples of the joint calculation

Finally, examination of results and *Results Analysis* are possible in the *ANALYSIS* module, Figure 8. This module notes resulting from the calculation, help to interpret the calculation report and displays options. Using the commands buttons *Detailed Indications, Main Indications* or *Important Indications*, the software attributes a color (red, green, blue or black) according to the importance of the message.

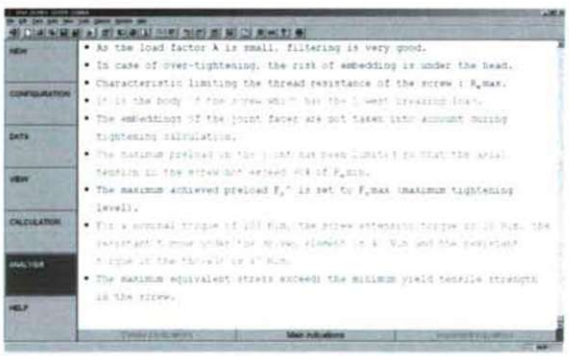


Figure. 8. Resulting messages in the ANALYSIS module

The final calculation report can be displayed on the screen or printed, with content from all of the active modules: the input data from CONFIGURATION and DATA modules; the views of

the joint, from the VIEW module; the results of pre-stressed bolted joint calculation (according to the checked options in the "Report layout" dialog box) from the CALCULATION module; the current analysis messages from the ANALYSIS module. This calculation report file can be exported in an .rtf file and afterwards loaded in an word-processing software.
An important facility of this software is the efficiently *context help*, respectively a theoretical handbook, technical documents, knowledge base, Pictures and a Video library. The described CETIM Cobra software can check dimensions of an existing joint, when working loadings must be modified and the design of a new joint is not possible.

5. DISCUSIONS, APPROACHES, APPLICATION AREA AND LIMITS

The Cetim-Cobra calculation method determines the optimal preload to fulfill the nonopening and/or non-sliding of the clamped parts. These joints necessarily use high duty fasteners and a controlled tightening.
When a joint comprises several fasteners, a mechanical analysis of the external loadings will have to be carried out beforehand, in order to define the resultant loads related to the calculated fastener: axial load, transverse load, bending moment.
Cetim-Cobra can only treat joints which have a continuous volume of material around the bolt, and this volume must be entirely compressed. The described design software tool Cetim-Cobra is available for the dimensioning of bolted assemblies with a controlled prestress. It allows prestress levels to be determined, for given loading conditions, and verifies the fatigue resistance of assemblies subjected to cyclic loading.
The geometry, materials and mechanical and thermal loadings are entered and the software calculates stresses and strengths (from a material database if required). The fatigue behaviour is then checked and partial safety factors are determined. The programme runs under Windows (English, French and German versions) and it includes graphical options for displaying the results.
The most frequent causes of failure of bolt connections are the following: Incorrect knowledge of actual occurrence and action of external forces; Additional bending stress in the bolt due to shape and position deviations of the bolts and nuts; Loss of pre-stressing caused by thermal elongation or plastic deformation of the bolt and connected parts; Spontaneous loosening due to shaking; Chemical or electrochemical attack, corrosion; Breaks of connection bolts exposed to variable loading.

6. CONCLUSION

The complexity of an optimized bolted joint calculation represents many work hours for a designer perfectly initiated with the specific calculation methods. In order to avoid long and expensive developments, the designer uses various "safety factors" involving an oversized joint designing. Even if it's obvious that this approach can't allow any cost-cutting, we have to point out that oversizing can sometimes decrease the mechanical resistance of the joint.
The large possibilities of a design and analysis software for pre-stressed bolted joints and the widespread of computer equipment in all branches of industry, [2], increases the possibility of using it in every phase of development or implementation of the joints.

Table 1.

Type of company	Phase of implementation	Typical use
Engineering	Design	Optimization
Mechanical manufacturing	Manufacturing	Processing control
Mechanical engineering	Assembly	Definition of the procedures
All types	Operating	Monitoring in service

For some safety systems, the calculation speed of the software allows a reduction of plant shut-downs.

Therefore, the integration of a computer aided design software in the concept process saves time, allows more exact calculations and deletion of some "safety factors" masking the lack of knowledge of the problem.

Once the complexity of the calculations is no longer a drawback, the designer will be able to consider several allowable configurations and to make a choice according to economic criteria.

Integrating CAD's basic concepts, namely the use of a specifically design and analysis software (for example the Cetim Cobra software), in the instruction period of the futures engineers in the mechanical domain is a very efficient education technique.

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CONSIDERATION REGARDING THE QUALITY OF THE STEEL USED FOR MAKING ROLLING STOCK COMPONENTS

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Faculty Engineering Hunedoara,

ABSTRACT

The work presents the manner of settlement of the specific problems of steel ingot cast in a smooth cylinder format and its use as semi-finished product, compatible with the manufacturing of monoblock wheels, under the quality conditions thereof imposed by the manufacturing regulations. By means of the proposed research and experiments we intend to get to know the specific characteristics of the ingot and the optimization thereof in order to satisfy the quality requirements imposed on the products (monoblock wheels). During the manufacturing of wheels the chemical composition and the gas content (hydrogen, nitrogen, oxygen) are to a large extent the decisive elements regarding the obtaining of the main characteristics of the wheals corroborated with the hot deformation of the cast semi-finished product and the adequate thermal treatment. The main physical and mechanical characteristics established for the wheels are: resistance to rupture; yield point; elastic limit; elongation; rupture resistance or energy upon shock bending; strength; K1C tenacity.

KEYWORDS:
steel, quality, monoblock wheel, rolling stock

1. INTRODUCTION

Various flow sheets are used, around the world, for the manufacturing of monoblock railroad wheels, which use as raw material semi-finished goods cut from ingots or blooms.
The casting process for the steel wheels is constantly improved, which ensures an increase of the quality and efficiency of their production.
In Romania the manufacturing of monoblock railroad wheels is 35 years old in the former Factory of Axles and Bogies of Balş, which is currently called SC Subansambluri de Material Rulant – SA.
For the manufacturing of monoblock railroad wheels we have the following main technological processes: the obtaining of the starting semi-finished product which includes – the manufacturing of the steel, the casting of the ingots, the potential rolling of the blooms, the division of the ingots or blooms; the forging of the wheels which includes: the heating of the bars resulting from the division of the ingots or blooms, the actual forging with its stages (stamping, rolling, forming – calibration, perforation of the central hole in the hub), the cooling of the forged wheels; the thermal treatment of the wheels; the mechanical processing of the wheels which is usually performed in most of the cases in two stages, namely before and after the thermal treatment of the wheels [1].

2. RESEARCH RESULTS

Starting from the obtaining of the starting semi-finished product, we can very well say that until the manufacturing of an almost ideal semi-finished product, obtained by computer assisted development in duplex or triplex system continuously cast conjugate aggregates, certain improvements can be obtained even with the current equipment: a chemical and

structural homogeneity of the ingots; advanced purity regarding the non-metallic inclusions as well as the gases; economic format of semi-finished product.

The following shortcomings must be noted regarding the manufacturing of the liquid steel and the casting of the ingots: the full development of the steel in electric-arc furnaces is uneconomical, and the quality of the steel is not fully satisfying, due to the chemical and thermal inhomogeneity, the high content of endogenous inclusions and gas.

For the performed researches, objectives were established which could harmonize the influences of certain ingot technological manufacturing – casting factors upon the behavior of the semi-finished obtained product in the process of plastic deformation and upon the physical – mechanical characteristics of the manufactured wheels.

For the manufacturing of the monoblock railroad wheels high quality carbon steels are used and only in few cases attempts have been made regarding the use of alloy construction steels.

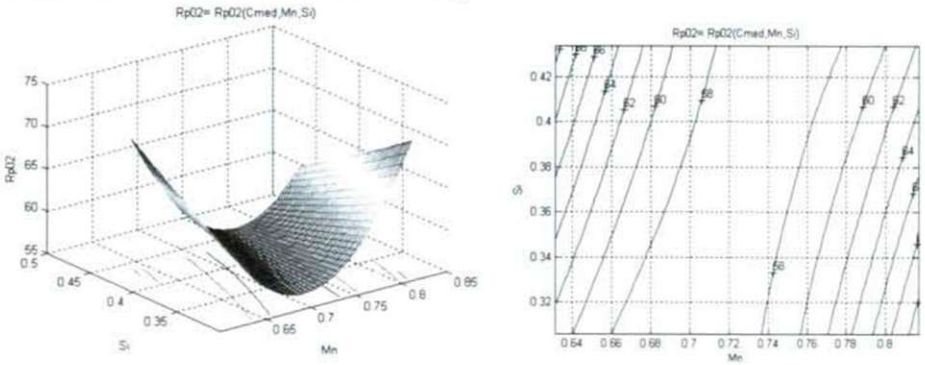
During the manufacturing of wheels the chemical composition and the gas content (hydrogen, nitrogen, oxygen) are to a large extent the decisive elements regarding the obtaining of the main characteristics of the wheals corroborated with the hot deformation of the cast semi-finished product and the adequate thermal treatment. The main physical and mechanical characteristics established for the wheels are: resistance to rupture; yield point; elastic limit; elongation; rupture resistance or energy upon shock bending; strength; K1C tenacity.

Experimental data obtained on the influence of chemical composition on the characteristics of resistance were processed in MATLAB computer program results are presented in graphical and analytical. Regression equations are hyper surfaces:

$$R_{p02} = 3166{,}0724 \cdot C^2 + 1058{,}3734 \cdot Mn^2 + 61{,}2307 \cdot Si^2 - 3325{,}4213 \cdot C \cdot Mn - 776{,}9659 \cdot Mn \cdot Si + 452{,}6587 \cdot Si \cdot C - 1385{,}3279 \cdot C + 676{,}2154 \cdot Mn + 258{,}2772 \cdot Si + 154{,}6653; \quad R^2 = 0{,}6786 \quad (1)$$

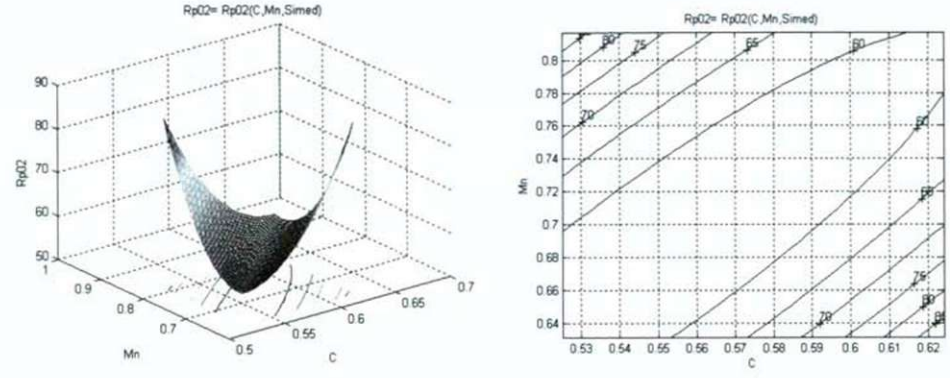
$$R_m = -5855{,}5287 \cdot C^2 + 744{,}9656 \cdot Mn^2 - 2965{,}8212 \cdot Si^2 + 311{,}5921 \cdot C \cdot Mn - 2718{,}9645 \cdot Mn \cdot Si + 10521{,}6074 \cdot Si \cdot C + 2666{,}5643 \cdot C - 256{,}6329 \cdot Mn - 1889{,}0331 \cdot Si - 246{,}9728; \quad R^2 = 0{,}8768 \quad (2)$$

Because these hyper surfaces can be represented in space with four dimensions, was used to replace, in succession, independent variables with each of its average value. Surface regression obtained and the contour lines are shown in Fig.1-6.



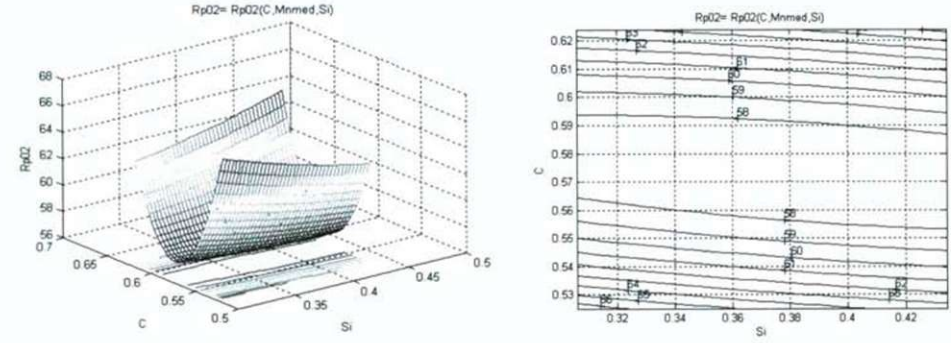
a. b.

Figure 1.$R_{p0,2}$ =f(C_{med}, Si, Mn). a – regression surface, b – contour lines



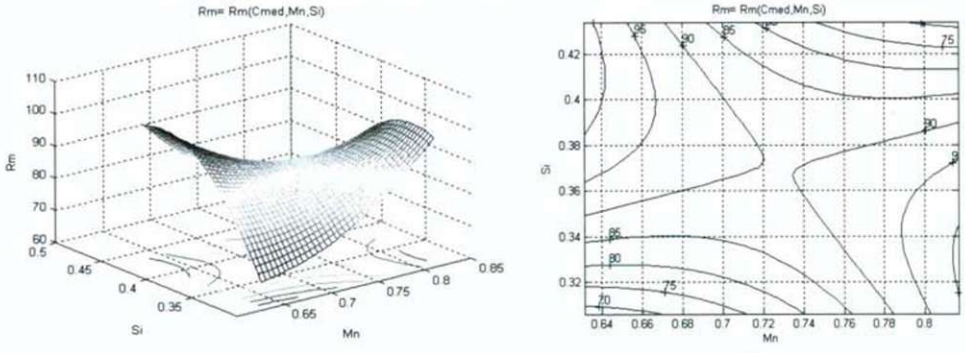
a. b.

Figure.2. $R_{p0,2}$ =f(C, Mn, Si_{med}). a – regression surface, b – contour lines



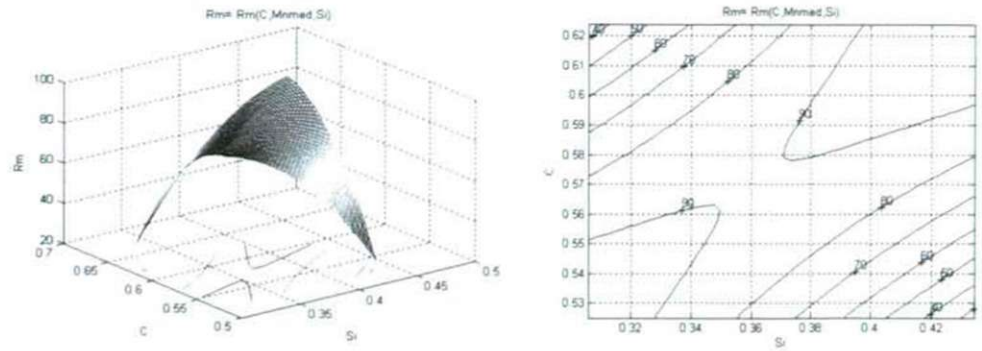
a. b.

Figure.3. $R_{p0,2}$ =f(C, Mn_{med}, Si). a – regression surface, b – contour lines



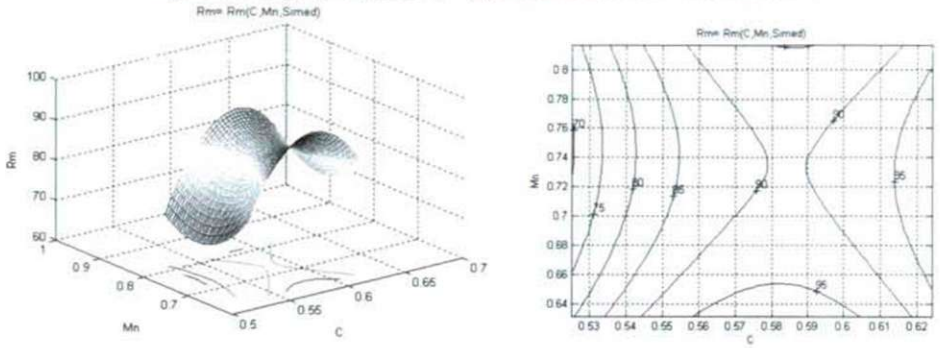
a. b.

Figure.4. R_m =f(C_{med}, Mn, Si). a – regression surface, b – contour lines



a. b.

Figure.5. R_m =f(C, Mn_{med}, Si). a – regression surface, b – contour lines



a. b.

Figure.6. R_m =f(C, Mn, Si_{med}). a – regression surface, b – contour lines

Surface regression equations for the mechanical strength are:

$$R_{p02}C_{med} = 1058{,}3734 \cdot Mn^2 + 61{,}2307 \cdot Si^2 - 776{,}9659 \cdot Mn \cdot Si - 1240{,}4365 \cdot Mn + 519{,}1733 \cdot Si + 407{,}9662 \quad (3)$$

$$R_{p02}Si_{med} = 3166{,}0724 \cdot C^2 + 1058{,}3734 \cdot Mn^2 - 3325{,}4213 \cdot C \cdot Mn - 1215{,}5809 \cdot C + 384{,}8532 \cdot Mn + 260,\ 1298 \quad (4)$$

$$R_{p02}Mn_{med} = 61{,}2307 \cdot Si^2 + 3166{,}0724 \cdot C^2 + 452{,}6587 \cdot Si \cdot C - 307{,}142 \cdot Si - 3805{,}3277 \cdot C + 1207{,}2665 \quad (5)$$

$$R_mC_{med} = 744{,}9656 \cdot Mn^2 - 2965{,}8212 \cdot Si^2 - 2718{,}9645 \cdot Mn \cdot Si - 77{,}0426 \cdot Mn + 4175{,}2388 \cdot Si - 655{,}2397 \quad (6)$$

$$R_mMn_{med} = -2965{,}8212 \cdot Si^2 - 5855{,}5287 \cdot C^2 + 10521{,}6074 \cdot Si \cdot C - 3867{,}6977 \cdot Si + 2893{,}3184 \cdot C - 39{,}2075 \quad (7)$$

$$R_mSi_{med} = -5855{,}5287 \cdot C^2 + 744{,}9656 \cdot Mn^2 + 311{,}5921 \cdot C \cdot Mn + 6612{,}1671 \cdot C - 1276{,}2446 \cdot Mn - 1372{,}4289 \quad (8)$$

3. CONCLUSIONS AND PROPOSALS

From the analysis of the data processed in a graphic and analytical form a series of conclusions can be drawn:

- the increase of the resistance to traction and of the yield point with the increase of the carbon content is due on the one hand to the increase of the pearlite ratio in the structure,

constituent with superior values for these characteristics, and on the other hand due to the favorable action of the carbon upon the deoxidation and desulphuration process;

manganese as element which is present in almost all steels dissolves in iron and forms solid solutions increasing their resistance. On the other hand, the manganese from the steel also has a deoxidation and desulphuration role, which can be noticed in the improved resistance characteristics;

- regarding the silicon, it dissolves in ferrite increasing its resistance and toughness. At the same time, the silicon is also a deoxidizing agent with a great deoxidation power having the capacity to calm the steel completely and as a consequence decreases progressively the oxygen content of the steel, element which has a negative influence upon quality;
- in the analyzed steels phosphorous is present in very small concentrations and therefore it causes no negative effects, on the contrary when dissolved in iron it leads to the formation of mixed crystals which in their turn determine an increase of the toughness of the steel. The existing phosphorous content of the analyzed steel does not create the risk of the formation of a ternary eutectic $Fe_3P - Fe - C$ with a melting temperature of 953°C which would cause the cracking of the ingot upon its processing due to the plastic deformation;
- regarding the sulphur content a decrease of the values for resistance to concentrations of more than 0.018% was found. Regarding the range of 0.011-0.018% we can say that its negative influence is insignificant. We believe that for values between 0.018 and 0.022% an inhomogeneity may exist regarding the distribution of the sulphur in the structure of the ingot, which may influence its characteristics;

Further research shall be performed in order to establish certain complex dependence relations, namely the data will be processed with the Matlab software by analyzing the influence of three independent factors (C, Mn, Si) upon the independent parameters (tensile resistance, yield point etc) and based on the obtained results we will be able to establish an optimal chemical composition. Moreover, we will also have in view the establishing of the dependence relations for other characteristics: toughness, resilience, elongation, as well as the gases content of the steel (a very important aspect for the steels destined for the manufacturing of rolling stock components).

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QUALITY PARAMETERS OF MIXED WINTER WHEAT FLOUR WITH AMARANTH FLOUR

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ABSTRACT

Grain amaranth (Amaranthus hypochondriacus) has gained increased attention since 1970s when it has been rediscovered. It has been cultivated in the Mayan civilization of South and Central America. This plant is produced as a grain and as a vegetable. Amaranth is quite nutritious. Amounts of vitamin C, iron, carotene, calcium, folic acid. Both the leaves and seeds contain protein of an unusually high quality The protein is high in the amino acide lysine, which is the limiting amino acid in cereals like maize, wheat and rice. The protein is also relatively rich in the sulfur-containing amino acid, which are normally limiting in the pulse crops. In our work we have analysed the quality of winter wheat, especially the alveographical and extensigraphical parameters, wet gluten content and gluten expansiveness.

1. INTRODUCTION

Amaranth has been cultivated for 8,000 years in Aztecs word (Robert, 2002).
Now grain amaranth is known hardly in agriculture fields in North America and Europe, but range of amaranth products are sold in health food shop in Europe (Aufhammer, 2000).
Chaturvedi et al.(1997) according to the protein is high in the amino acide lysine, which is the limiting amino acid is cereals like maize, wheat and rice. The protein is relatively rich in the sulphur-containing amino acids, which are normally limiting in the pulse crops, it has not gluten contain.
The quality of wheat is a complex concept (Lásztity, 1980, Matuz et al., 1993, Véha and Gyimes, 1999). The alveograph is suitable for the examination of rheological characteristics which characterises the extensibility of dough (Rakszegi et al., 2005). This method gives extra information for backing tests (Zsikla, 2005).
Vida et al. (1996) analysed the relation between the alveographical and other baking industry quality characteristics of 19 winter wheat varieties and they established the close positive correlation between the alveographical G, W and gluten index with statistical method.
The alveographical G and W are in satisfactory significant relation with the wet gluten content (Tanács et al., 2008).
Matuz el al. (1999) established the values and the value relation of 13 parameters (among others alveographical P, L, P/L, W, G wet gluten content, spreading of wet gluten) of 29 winter wheat varieties produced in 1995, 1996 and 1997. The aim of their analyses was to define the parameter that has the closest correlation with the alveographical W.

2. MATERIAL AND METHODS

The winter wheat and grain amaranth samples came from mill industry from 2009 cropping year, these are industrial flour samples. We made alveographical examinations with SMS2

texture analyser (ISO 5530-4:1991) and extensigraph research with Brabender extensigraph (ISO 5530-2:1997). Wet gluten content and gluten expansiveness were analysed with MSZ 6369/5-87 standard. The parameters were analysed in Laboratory of ABO-MILL ZRt. in Törökszentmiklós, Hungary (Table 1).

Table 1: Methodes and instruments in analysis

Examination	Method	Instrument
Moisture content	MSZ 6369/4-1987	LP 303 type dryer machine
Examination by Farinograph	MSZ 6369/6-1998	Brabender farinograph
Extenzigraphical examination (Brabender)	ISO 5530-2:1997	Brabender extensigraph
Kneading for Alveographical examination (Dobraszczyk) SMS2 texture analyser	ISO 5530-4:1991	Chopin MR 2L Rotary Mixer
Alveographical examination (Dobraszczyk) SMS2 texture analyser	ISO 5530-4:1991	SMS2 Texture Analyser (Dobraszczyk) D/R system
Wet gluten content	MSZ 6369/5-87	Glutomatic
Gluten expansiveness	MSZ 6369/5-87	Glutomatic

3. RESULTS AND DISCUSSION

During examination we used the following mixing ratio: control winter wheat flour, 95% winter wheat flour+5%amaranth flour, 90% winter wheat flour+10%amaranth flour, 85% winter wheat flour+15%amaranth flour, 80% winter wheat flour+20%amaranth flour. Table 2 shows the wet gluten content and gluten expansiveness. Parameters show, that increasing of quantity of grain amaranth resulted decrease of wet gluten contant, but gluten expansiveness not changed.

Table 2: Wet gluten content (%) and gluten expansiveness (mm/h) parameters

mixture	wet gluten content (%)	gluten expansiveness (mm/h)
winter wheat flour	29,4	1,5
95%winter wheat flour+5% amaranth flour	29,0	1,5
90%winter wheat flour+10% amaranth flour	25,9	1,5
85%winter wheat flour+15% amaranth flour	25,05	1,5
80%winter wheat flour+20% amaranth flour	20,20	2,0

During measuring I specified alveographical W, P, L and P/L value. I analysed tree parallel measuring. Table 3 shows the average values.We can see in table 2, that increasing of quantity of grain amaranth resulted decrease of W, P and L parameters. According to requirement of French baking industry, various bread types were determined. Cardinal parameter the P/L. P/L value of cracker and paste are from 0,4 to 0,5 values, traditional bread 0,6±0,1 and brioche 0,7±0,1. The date in table 2 show high values.

Table 3: Alveographical parameters with SMS2 texture analyser

mixture	W (10^{-4}J/g)	P (mm)	L (mm)	P/L
winter wheat flour (control)	233	110	84	1,32
95%winter wheat flour+5% amaranth flour	201	122	51	2,44
90%winter wheat flour+10% amaranth flour	168	121	36	3,41
85%winter wheat flour+15% amaranth flour	140	118	28	4,44
80%winter wheat flour+20% amaranth flour	139	153	18	8,62

I specified extensographical energy, resistance to extension, extensibility and extensibility ratio values, too. The table 4 show, that increase of quantity of grain amaranth resulted decrease of energy, resistance to extension and extensibility parameters.
In table 4 we can see, that every parameters decreased with increase of quantity of grain amaranth.

Table 4: Extensigraphical parameters with Brabender extensigraph

mixture	Energy (cm^2)	Resistance to extension (BU)	Extensibility (mm)	Entensibility ratio value
winter wheat flour	92	336	151	2,2
95%winter wheat flour+5% amaranth flour	79	332	142	2,3
90%winter wheat flour+10% amaranth flour	66	278	149	1,9
85%winter wheat flour+15% amaranth flour	54	278	128	2,2
80%winter wheat flour+20% amaranth flour	43	278	113	2,5

Nowadays, there is a growing claim for the special rheological examinations, mostly for the extensibility and resistance of extension parameters both in the international and most of the Hungarian wheat export markets. We have to analyse the alveographical and extensigraphical parameters of Hungarian growing winter wheat to help to realize the alveographical and extensigraphical quality and qualification. The correlation among some quality parameters can give us extra information about backing values of winter wheat varieties, selection of special quality types for wheat growing and qualification of the different export rate. Grain amaranth is a new crop that is in its adolescence. The cultivation and utilization of grain amaranth will continue to increase as more information is developed to exploit the market niches for high quality protein foods. This extra information can give us help to select special quality types for wheat growing and qualify the different export rate.

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INFLUENCE OF DIFFERENT CATALYSTS ON TRANSESTERIFICATION OF SUNFLOWER OIL

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ABSTRACT

Biodiesel, nontoxic environmentally-friendly renewable fuel, is a mixture of different fatty acid methyl esters produced by transesterification of vegetable oil triglycerides. Content of particular FAMEs is one of the qualities of biodiesel that is regulated (standard EN 14214). FAME composition of biodiesel depends upon the feedstock and its quality. In Serbia for production of biodiesel rapeseed and sunflower oil (SFO) are mostly used, although waste frying oil from household and restaurants is possible and economically more favorable feedstock.
Since transesterification of triglycerides is catalyzed reaction, aim of this work was to investigate the influence of different catalysts on FAMEs yield. NaOCH3, NaOH and KOH with HCl were studied as the catalyst for reaction of transesterification. FAMEs mixtures derived by transesterification of refined and different waste frying SFO samples in the presence of mentioned catalysts were qualitatively and quantitatively analyzed using gas chromatograph coupled with mass spectrometer as a detector.
Content of FAMEs was the highest both for refined and waste frying SFOs when KOH and HCl were used as catalyst for transesterification. The method which uses KOH and HCl as catalyst was the fastest among investigated methods.

1. INTRODUCTION

A shortage of fossil fuel recourses, alongside high prices of these fuels, has caused intensive researches in the field of renewable fuels. Biodiesel is nontoxic environmentally-friendly renewable fuel which is produced from animal fats and vegetable oils. It can be used solely, or as a mixture of different ratios with fossil diesel, as a fuel for diesel engines. Biodiesel is a mixture of fatty acid methyl esters (FAMEs) that are produced by transesterification of triglycerides of vegetable oils or animal fats. In Serbia the most important feedstock for production of biodiesel are rapeseed and sunflower oil. Although vegetable oils are main feedstock for biodiesel production, waste frying oils from restaurants and households are possible and economically more favorable feedstock. Properties of biodiesel are regulated by standard EN 14214, which specifies, among others, the FAMEs content in fuel [1]. This content, on the other hand, depends upon feedstock qualities, as well as production i.e. transesterification method.
Transesterification (alcoholysis) is catalyzed reaction of vegetable oils' triglyceride and alcohol, usually primary or secondary aliphatic ones, resulting in a formation of fatty acid alkyl ester and glycerol. In a case of methanol, as mostly used alcohol, different fatty acid methyl esters (FAMEs) are obtained [2, 3]. Wide range of parameters has an influence on the

rate of the transesterification of the triglycerides from vegetable oils: molar ratio of the reactants, temperature, reaction time, stirring rate and type of catalyst [2, 3]. Possible catalysts for transesterification are acid, alkali or enzyme. According to the literature data reaction with alkali catalysts is faster that the transesterification with acid catalysts and less corrosive. Researches of enzymatic catalysts have started recently; however, their use is still expensive and time-consuming. Possible alkali catalysts are NaOH, KOH, $NaOCH_3$, $KOCH_3$ and carbonates [2, 3].
In this work the influence of three alkali catalysts namely NaOH, $NaOCH_3$ and KOH with HCl was investigated with aim to determine which one gives the highest yield of FAMEs. Gas chromatography coupled with mass spectrometry was used for qualitative and quantitative determination of FAMEs content in samples of transesterified refined (RSFO) and waste frying sunflower oil (WFSFO). The results of transesterification of WFSFO were compared with the results of RSFO.

2. EXPERIMENTAL

2.1. Materials

Two WFSFO samples, one collected from household and the other from restaurant, with experimentally measured iodine numbers 104.76 and 101.62 and acid values 2.21 and 2.58, respectively, and RSFO sample with an iodine number of 113.94 and an acid value of 6.68 provided by "AD Dubravka", were used for transesterification. For GC-MS analysis FAME mix C8-C22 18920-1AMP, producer Supelco, Bellefonte was used as external standard.

2.2. Methods

The Hanus method for the iodine number [4] and the AOCS Cd 3a-63 method for the acid value [5] were used in this work.
Acid value is determined by neutralizing 1-2 g of oil diluted in 50 ml of acetone with 0.1M solution of KOH in alcohol in the presence of phenolphthalein as an indicator.
Transesterification of 100 mg of oil sample with 10 ml of freshly prepared 0.28M solution of $NaOCH_3$ in methanol is done on 75°C for 20 minutes with constant stirring rate 1000 rpm in round bottom flask equipped with condenser. Mixture is transferred into the separation funnel where 20 ml saturated NaCl solution is added. FAMEs are extracted by adding 10 ml diethylether and 50 ml distillated water. FAMEs from water layer are extracted one more time with 15 ml diethylether after separation of the layers. Organic layers from first and second extraction are joined are dried by adding Na_2SO_4. Sample is left over night, filtrated and evaporated (35°C, atmospheric pressure) to 1 ml [6].
Transesterification with NaOH is used for neutral oils with acid value below 2. 0.5 ml methanol solution of NaOH (1 mol/l) is added to mixture of 4 g oil and 40 ml methanol. Mixture should be heated up to a boiling point. The reaction reaches end point when mixture becomes clear usually after 5-10 minutes. After cooling, 20 ml heptane and 40 ml water are added to the mixture. FAMEs layer is separated and dried with Na_2SO_4. After filtration solvent is removed by evaporation (50°C, 150mbar) [7].

First step of transesterification with KOH and HCl is saponification of triglycerides with KOH and the second step is esterification of the soaps in the presence of HCl into FAMEs. 120 mg of oil is placed in 10 ml tube with ground cork. After adding 2.4 ml petrol ether, a mixture is shaken for 10 s. 0.6 ml methanol solution of KOH (2 mol/l) is added to the mixture which should be shaken again for 20 s. The mixture is heated for 1 minute in water bath at 60°C. After the mixture is shaken for 20 s, 1.2 ml HCl solution in methanol (1 mol/l) is added. 4 ml petrol ether is added in tube. After shaking ester layer is removed. Petrol ether is removed by evaporation in nitrogen stream up to 1 ml [8].

The cleanup of the FAME samples before GC-MS was done on silica gel column which was prepared inside Pasteur pipette. Glass wool is placed on the bottom of the pipette. 0.3 g activated silica (heated at 120°C for 2h) and 0.3 g anhydrous Na_2SO_4 are put above the wool, respectively. The column is conditioned with 5 ml cyclohexane. After the sample is applied, FAMEs are eluted with 5 ml mixture cyclohexane:ethylacetate=2:1 v/v. Elute is collected is 25 ml round bottom flask. After adding 1 ml toluene, sample is evaporated up to 1 ml.

GC/MS system consisting of instruments Trace GC and Trace MS, Thermo Finnigan, Germany with capillary column OPTIMA 240, Machery Nagel: 60m × 0.25mm ID × 0.25 μm film thickness was used for analysis of the samples after transesterification. Working temperature of GC column was programmed as follows: initial temperature 80°C, 20°C/min to 120°C, 3°C/min to 240°C that was held for 10 min. Helium flow of 1.5 ml/min was constant. 1 μl of the sample was injected automatically by AS 2000 autosampler, Thermo Finnigan, Germany. PTV injector, which was working with split ratio 10:1, had initial temperature 60°C that was constantly risen 14.5°C/min up to 260°C. MS parameters were set to following values: interface temperature 250°C, ion source temperature 220°C, ionization energy 70eV. Full scan mode was done with ion mass range 50-500 a.m.u. For quantitative analysis of the samples by external standard method SIM technique was used.

Qualitative analysis of the FAME was done applying NIST library of mass spectra for EI.

Total relative content of FAMEs which represents mass fraction of FAMEs (C14:0-C21:1) in sample after transesterification is determined by modified standard method JUS EN 14103 [9]. Methyl ester of margaric acid is used in this method as internal standard.

Relative content of each FAME was determined by modified AOAC-IUPAC method [10]. Relative content of FAMEs was calculated after assessing of correction factors for transfering area into mass fractions.

Content of each FAME was determined by external standard method. FAME standard solutions in hexane of following concentrations 0.005 mg/ml, 0.05 mg/ml, 0.25 mg/ml, 0.5 mg/ml and 1 mg/ml were used for obtaining a calibration curve. Blank sample, standards and samples were analyzed in triplicate.

3. RESULTS AND DISCUSSION

Determined acid values of the RSFO and WFSFO from household and restaurant were 6.68, 2.21 and 2.58 (analysis were done in triplicate expressing results as mean value), respectively. Since acid values of all samples were higher than 2, transesterification with NaOH was not applicable.

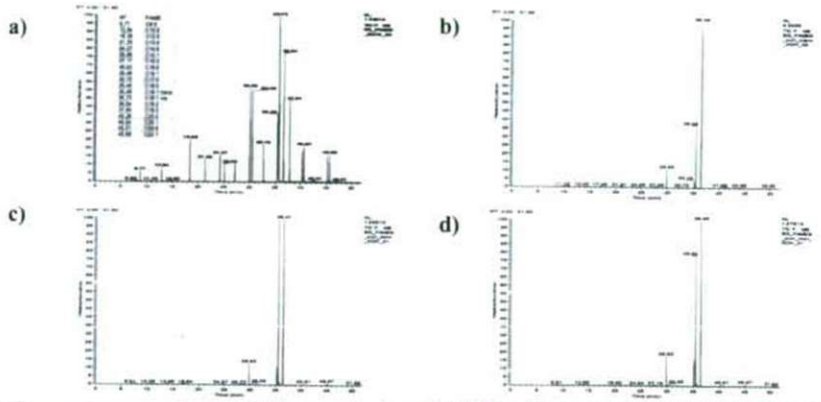

Figure 1. Chromatograms of: a) FAMEs standard and FAMEs obtained from b) RSFO c)WFSFO household d) WFSFO restaurant

Chromatograms of FAMEs standard and FAMEs obtained from RSWO, household and restaurant WFSFO when KOH with HCl was used as catalyst are shown in Figure 1. For all analyzed samples peaks of FAME C14:0, C15:0 C16:0, C16:1, C17:0 C18:0, C18:1 cis, C18:2 cis, C18:2 trans, C18:3, C16:1, C20:0, C20:1 and C20:1 are well separated.
Total relative content of FAMEs, shown in Table 1, is higher for all samples when KOH with HCl was used as catalyst, instead of $NaOCH_3$.

Table 1. Total relative content of FAMEs obtained by transesterification of RSFO and WFSFO

Sample	Total relative content of FAMEs (%)	
	$NaOCH_3$	KOH+HCl
RSFO	86.58	99.33
WFSFO Household	88.94	99.96
	79.79	96.23

Relative content of FAMEs (%) is given in Table 2. Since the standard mixture does not contain trans form of linoleic acid, content of linoleic acid was calculated as sum of its trans and cis form using correction factor for cis form. A choice of the catalyst reflected the most on the relative content of obtained FAMEs in the case of RSFO. Change of relative content of two dominant FAMEs, namely C18:1 cis and C18:2 cis+trans, for both WFSFO samples was less than 0.9%.

Table 2. Relative content of FAMEs obtained by transesterification of RSFO and WFSFO

FAME	Relative content of FAMEs (%)					
	RSFO		Household WFSFO		Restaurant WFSFO	
	$NaOCH_3$	KOH+HCl	$NaOCH_3$	KOH+HCl	$NaOCH_3$	KOH+HCl
C14:0	0.09	ND	0.07	0.05	0.14	0.11
C15:0	ND	ND	0.01	0.01	ND	ND
C16:0	5.53	6.21	7.25	6.53	9.59	9.84
C16:1	ND	ND	0.50	0.30	0.66	0.38
C17:0	ND	ND	ND	ND	ND	ND
C18:0	7.83	0.77	3.98	3.65	5.73	5.71
C18:1 cis	28.09	16.96	38.03	38.58	28.03	28.69
C18:2 cis+trans	55.92	76.07	49.19	50.17	54.86	54.44
C18:3	0.31	ND	0.15	0.10	0.18	0.10
C20:0	0.55	ND	0.18	0.13	0.22	0.19
C20:1	0.25	ND	0.18	0.13	0.22	0.18
C22:0	1.43	ND	0.46	0.34	0.37	0.35

The contents of detected FAMEs (mg/g) are given in Table 3. Total FAMEs yield was higher for all samples when transesterification was catalyzed by KOH with HCl. The highest influence of catalyst was observed when RSFO was transesterified: the FAMEs yield was 306.53 mg/g when $NaOCH_3$ was used as catalyst and 955.56 mg/g when KOH with HCl was applied as catalyst. The highest yield of FAMEs 957.32 mg/g was obtained when RSFO was transesterified in the presence of KOH with HCl.

Table 3. Content of FAMEs determined by external standard method

FAME	FAMEs content (mg/g)					
	Raw SFO		Household WFSFO		Restaurant WFSFO	
	$NaOCH_3$	KOH+HCl	$NaOCH_3$	KOH+HCl	$NaOCH_3$	KOH+HCl
C14:0	0.05	1.76	0.59	0.94	1.10	3.60
C15:0	0.08	0.29	0.17	0.13	0.12	0.23
C16:0	16.70	42.50	58.47	53.84	59.42	63.91
C16:1	1.27	3.75	4.01	4.51	4.50	5.82
C17:0	0.19	0.31	0.46	0.41	0.55	0.65
C18:0	29.02	37.09	47.59	35.82	40.24	45.02
C18:1 cis	84.75	212.53	372.06	390.86	165.01	179.42
C18:2 cis+trans	159.49	629.83	417.47	452.68	347.46	566.75
C18:3	2.52	8.26	9.23	9.64	7.81	7.94
C20:0	2.28	6.29	2.35	2.06	2.14	6.46
C20:1	2.80	3.74	1.11	1.06	0.56	0.79
C22:0	7.38	9.21	6.56	5.37	4.68	9.95
SUM	306.53	955.56	920.07	957.32	633.59	890.54

4. CONCLUSION

NaOH was not used as a catalyst since acid values of RSFO and both WFSFO were higher than 2. Total relative content of FAMEs and content of FAMEs in obtained mixture was higher for both refined and waste frying SFO when KOH with HCl was used as catalyst for trasesterification in comparison to $NaOCH_3$. Relative content of particular FAMEs is less dependent of the catalysts for WFSFOs than for the refined SFO. Transesterification of RSFO in the presence of KOH with HCl gave the highest yield.

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RESEARCH ON THE INFLUENCE OF BASIC ADDITIVES ON THE COMPRESSIVE STRENGTH OF PELLETS

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ABSTRACT

Besides the humidity, the granulometric composition and the specific surface of the pelleted material, the compressive strength of the pellets is also influenced by some additions with binding proprieties (bentonite, lime, limestone, dolomite, etc.). During the hardening process, these additions form a resistant slag that contributes to the binding of the granules of ferrous raw materials and, finally, to the increasing of the compressive strength of the pellets.
The paper presents the results of the laboratory experiments on the production of pellets by using secondary materials (steel plant dust, sludge from sintering and blast furnace plants, red mud, etc.) as raw materials, and lime/dolomite as a binder along with the bentonite.
To determine the influence of the addition of lime and dolomite on the compressive strength of pellets, we performed a series of experiments in the laboratory phase, consisting of the production of pellets based on various recipes, by adding bentonite & lime or bentonite & dolomite.
During the research, we aimed to establish correlations between the compressive strength of pellets and the additions of water, bentonite, lime or dolomite. The data obtained in the experiments were processed in Excel and MATLAB programs, resulting simple or multiple correlation equations. Based on these equations, we could establish the optimum addition of materials with basic character.
KEY WORDS:
pellet, compressive strength, lime, dolomite, iron oxide, calcium oxide

1. INTRODUCTION

Besides the humidity, the granulometric composition and the specific surface of the pelleted material, the compressive strength of the pellets is also influenced by some additions with binding proprieties (bentonite, lime, limestone, dolomite, etc.). During the hardening process, these additions form a resistant slag that contributes to the binding of the granules of ferrous raw materials and, finally, to the increasing of the compressive strength of the pellets. By using the lime as additive, simultaneously with the hardening process can appear various chemical combinations between the iron oxide and the calcium oxide, obtaining calcium ferrites, or between the iron oxide, silica and lime, obtaining calcium and iron silicates. In case of CaO additive in excess and basicity ration up to 1.8, we obtain calcium di-ferrite, $2CaO2Fe_2O_3$, which becomes friable in case of reduction at low temperatures.
When using dolomite as basic additive, the formation of calcium diferrite is avoided mostly due to the reduction of the CaO content. From the reaction between CaO and SiO_2 that takes

place in the gangue of the pelleted raw material, it results calcium silicates of $CaOSiO_2$ or $2CaOSiO_2$ types, which ensure a good binding of the material during the low temperature reduction process.

Regarding the influence of MgO, we have to mention the fact that this compound presents a very high melting temperature versus the pellet hardening temperature. As a consequence, MgO diffuses in the lattice of Fe_3O_4 and forms, in the solid phase, during the increasing of the magnetite grains, a magnetic magnesium compound called magnesioferrite, (Mg, Fe)O Fe_2O_3, which plays the role of a very strong binder and has a good oxidation stabilisation. Due to this quality, during the hardening treatment, the Fe_2O_3 remains mostly untransformed in Fe_3O_4. For this reason, at the low temperatures found in the upper zone of the blast furnace, the transformation of Fe_2O_3 in Fe_3O_4 stops. In these conditions, the pellets present a good breaking resistance.

Moreover, MgO increases the softening under load temperature of the pellets and the melting temperature.

The use of additives for increasing the resistance of the pellets should be made respecting an optimal proportion, this being the subject of the present research.

2. LABORATORY EXPERIMENTS

The experiments regarding the producing of pellets were performed in the laboratory "Energy and raw material base in industry", at the Engineering Faculty of Hunedoara. This laboratory is endowed with the installations required for producing pellets (volumetric ranking device, mixing drum, pellet making machine and hardening installation). The compression resistance has been determined by using the tension-compression test machine found in the "Strength of materials" laboratory of the faculty. The raw material used to produce pellets consisted of steel plant dust and red mud (resulted from alumina production). The compositions are presented in Table 1. We produced two sets of pellets, each set consisting of 3 lots.

Table 1

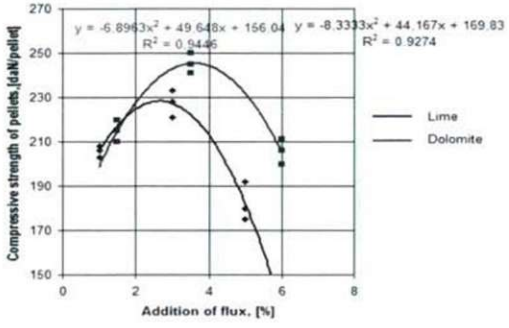
Set	Lot	Set	Lot	Remarks
A	A1 with 1% lime	B	B1 with 1.5% dolomite	In each set, the addition of bentonite ranged between 0 and 1% (i.e. 0%; 0.5% and 1%), and the addition of water ranged between 7.5 and 11.5%, (i.e. 7.5%, 9.5% and 11.5%)
	A2 with 3% lime		B2 with 3.5 dolomite	
	A3 with 5% lime		B3 with 5% dolomite	

The weight of the pellet batch was 2 kg (ferrous raw material, bentonite, lime/dolomite). The hardening of the pellets respected the combustion diagram of hematite ferrous materials. From each batch, we selected three pellets to determine their compression resistance. To establish the correlations, we took into account the average value.

3. RESULTS OBTAINED FROM PROCESSING THE EXPERIMENTAL DATA

By processing the data obtained in the laboratory phase, we obtained equations of correlation between the binder additives & water (considered as independent parameters) and the pellet compression resistance (considered as dependent parameter). The data were processed in Excel and MATLAB programs, the results being presented hereunder, in graphical and analytical forms.

The correlations obtained by processing the data in the Excel program are presented in Figs. 1-9, in graphical and analytical forms.



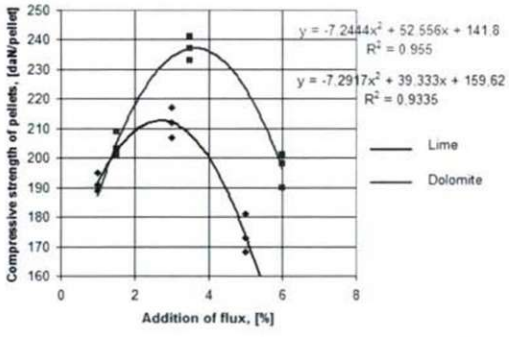
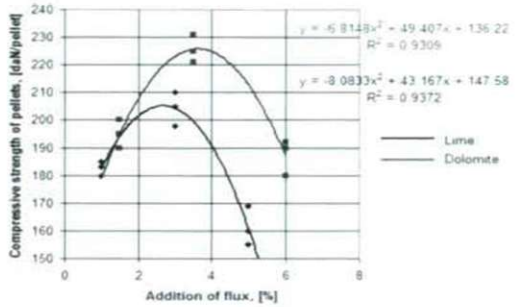


Figure 1. Variation of compressive strength of pellets (7.5 % water, 1% bentonite)

Figure.2. Variation of compressive strength of pellets (7,5% water, 0.5% bentonite)



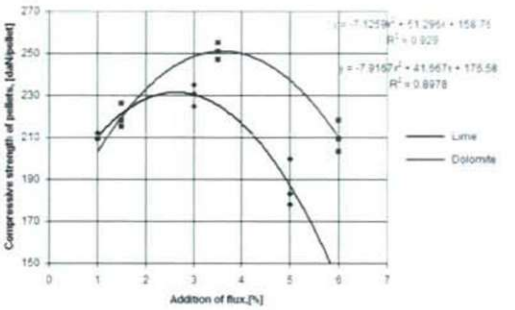
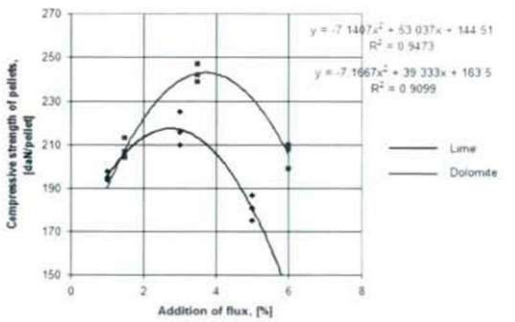


Figure 3. Variation of compressive strength of pellets (7.5 % water, 0% bentonite)

Figure 4. Variation of compressive strength of pellets (9,5% water, 1% bentonite)



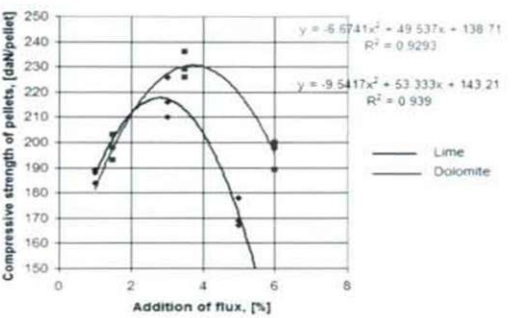
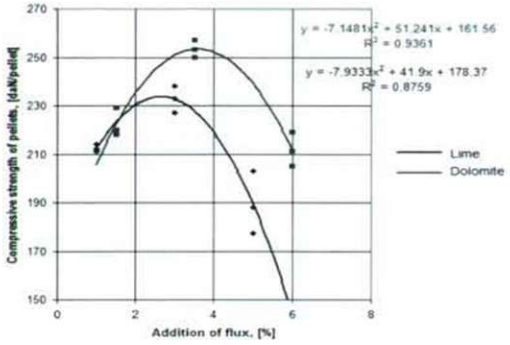


Figure 5. Variation of compressive strength of pellets (9.5 % water, 0.5% bentonite)

Figure.6. Variation of compressive strength of pellets (9,5% water, 0% bentonite)



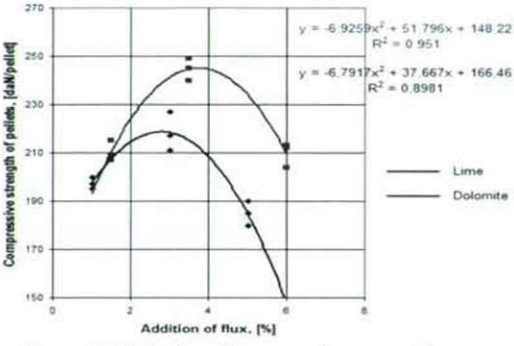


Figure 7. Variation of compressive strength of pellets (11.5 % water, 1% bentonite)

Figure 8. Variation of compressive strength of pellets (11.5% water, 0.5% bentonite)

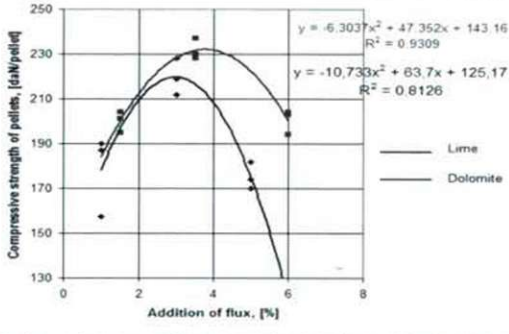


Figure 9. Variation of compressive strength of pellets (11.5% water, 0% bentonite)

Following the technical analysis of these data, it resulted:

- no matter whether we add lime or dolomite beside the bentonite, the compression resistance of the hardened pellets increases with increasing additive quantity, up to 2.5-3% (lime) and 3-3.5 (dolomite), indifferent of the bentonite and water additions; over these limits, the compression resistance decreases with increasing additive quantity;
- no matter whether we add flux or water, the compression resistance of the pellets increases with increasing bentonite addition;
- an increase of the water addition with 9.5-10.5% determines an increase of the compression resistance of the pellets.

The correlations obtained by processing the data in the Matlab program are presented in graphical form in Figs. 10-12.

$$z = 6{,}324 \cdot x^2 + 6{,}422 \cdot x + 1{,}542 + 39{,}021 \cdot y - 2{,}031 \cdot y^2 - 1{,}39 \cdot x \cdot y$$

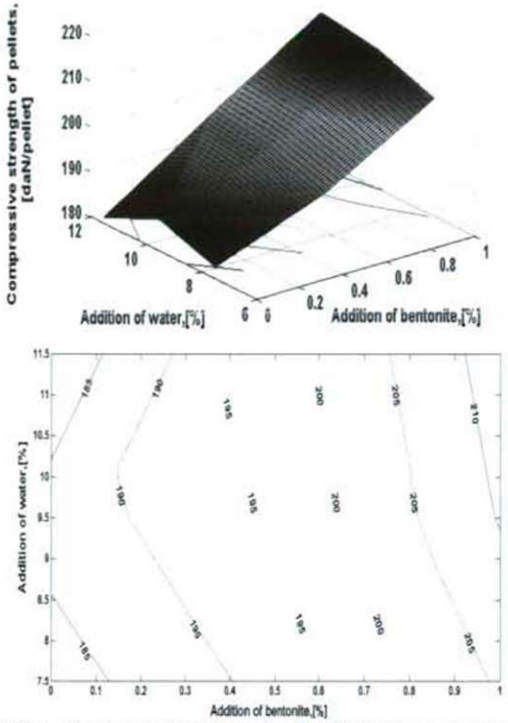


Figure 10. Variation of compressive strength of pellets to a concentration of 1% lime (x- addition of bentonite [%], y- addition of water [%], z-compressive strength of pellets, [daN/ pellet])

$$z = 24{,}334 \cdot x^2 + 21{,}536 \cdot x + 1{,}495 + 41{,}78 \cdot y - 1{,}989 \cdot y^2 - 3{,}092 \cdot x \cdot y$$

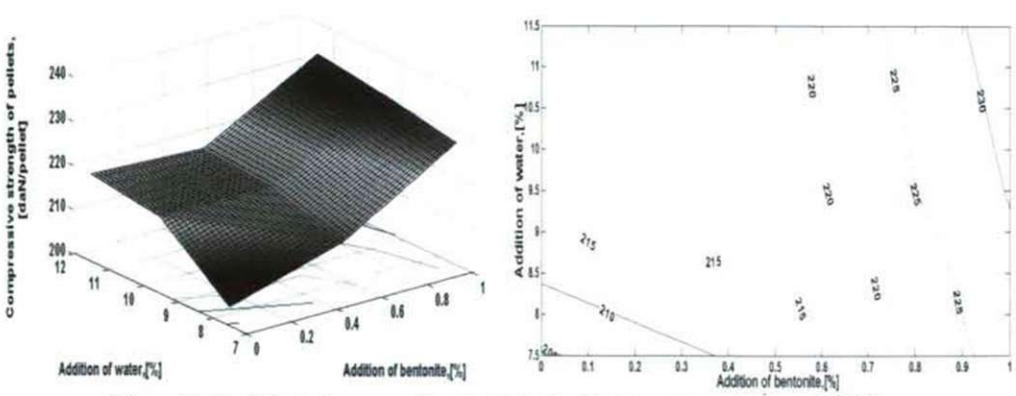


Figure 11. Variation of compressive strength of pellets to a concentration of 3% lime (x- addition of bentonite [%], y- addition of water [%],

z- compressive strength of pellets, [daN/ pellet])

$$z = -9{,}138 \cdot x^2 + 46{,}992 \cdot x + 1{,}121 + 32{,}315 \cdot y - 1{,}495 \cdot y^2 - 2{,}194 \cdot x \cdot y$$

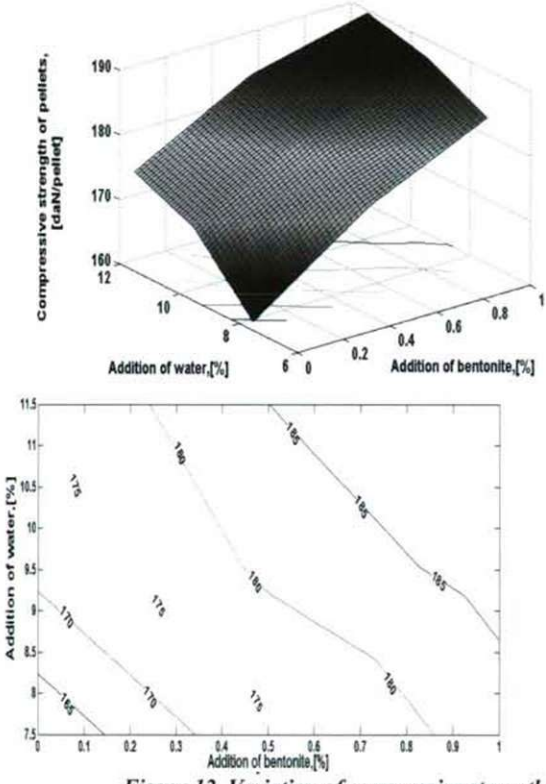


Figure 12. Variation of compressive strength of pellets to a concentration of 5% lime (x- addition of bentonite [%], y- addition of water [%], z- compressive strength of pellets, [daN/ pellet])

Analysing these correlations, we could establish the optimum domains for the flux, bentonite and water additions, in order to obtain higher pellet compression resistance values in case of flux addition.

4. CONCLUSIONS

Based on the experiments, on the results obtained from data processing and on the technical analysis of these data, the following conclusions resulted, in a nutshell:

- the two types of ferrous wastes (steel plant dust and red mud), both resulted from metallurgical processes, can be processed through pelleting. This means they can be used in the iron & steel industry;
- by adding flux, or lime or dolomite, the compression resistance of the hardened pellets increases when adding 2.5-3,5% flux;
- it is advisable to add 1% bentonite and 10-11% water, the upper limit corresponding to the higher limit of the added flux;

- by processing these wastes and transforming them in pellets fit to be used as raw or auxiliary materials in the iron & steel industry, the areas currently covered by them can be given back to nature, contributing in this way to the greening of the environment.

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REQUIREMENTS AND ASSESSMENT OF TRACEABILITY AT DISTRIBUTORS OF CEREAL ORIGIN FEED INGREDIENTS

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ABSTRACT

Achieving full traceability in food supply chains is not only a legal requirement but it brings multiple benefits both to customers and manufacturers. The paper reviews the minimal requirements and summarizes the results and learning of audits at 5 cereal origin feed ingredient manufacturers based on a questionnaire compiled for traceability from relevant European legislation and standards.

1. INTRODUCTION

In the last decades food distribution networks become more and more complex, and with globalisation this trend is likely to continue. Although there is an other trend that customers look for more information about their foods, the ingredients, the sources, and how they were made. These developments call for better and, in case of recalls, faster traceability not only in food but also in feed production. These needs got into the spotlight when serious food safety incidents broke out in the past years.

Efficient and reliable food and feed traceability is built on product identification, data and document recording and keeping, mapping routes of lots (through storage, process, distribution), systems to enable storing, maintaining, and linking data, and verification procedures. These elements together provide the ability to identify the routes and channels of products or ingredients through the supply chain from farm to fork.

2. LITERATURE REVIEW

Regulation (EC) N° 178/2002 provides the legal frame for food and feed traceability, outlining the general principles, requirements and procedures. From the 1st January 2005 it is mandatory to comply with traceability requirements for all food and feed producers along the supply chain. The establishment of comprehensive traceability systems is the prerequisite to provide information and to undertake accurate withdrawals with minimal disruption in case of food safety issues.

The legislation defines traceability as the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution. By definition, all

participant of the food chain, (from farm to fork), must get aligned on operating adequate traceability systems.

The cornerstones of traceability are identification, segregation, data collection and management, labeling and verification. The regulation obligates the relevant businesses to identify the sources and origin of inputs of the operation including food, a feed, a food-producing animal, or any substance intended to be added into the feed or food. These businesses should be also able to identify the destinations of outputs of their operations to which they were distributed, "one step back"-"one step forward" approach. The food and feed producers shall be able to demonstrate that traceability systems and procedures are in place and information is available for authorities on request. Traceability is also facilitated through product labels and relevant documentation. A proper system has to enable traceability not only downwards from farms to shops, but upwards also (from shops back to farms). However, food business operators do not have to identify the immediate customers when they are final consumers.

The Standing Committee on the Food Chain and Animal Health of EU provided a guidance document in the end of 2004 to answer the practical questions of European food chain operators and third country trading partners and to help them correctly apply solutions for traceability requirements. In the beginning of 2010 a revised version of the guidance document was published where certain sections were simplified and clarified. It is clearly stated that traceability alone does not make food safe, but it is a way of assisting in containing a food safety problem. As minimal requirement, food and feed businesses should document the names of suppliers, their addresses where the raw materials arrived from, the name and address of customers, and, of course the name of the product and date of delivery. Referring to food incidents in the past, the guidance document indicates the importance of traceability records as critical help in targeted recalls, enabling to maintain consumer confidence and facilitate risk assessments by authorities. Keeping quantity, batch numbers and more detailed description of the product is also recommended with the traceability records for at least the period of the shelf-life plus 6 months, however commercial documents are usually kept for 5 years, traceability systems hold information for the same duration.

The guidance document clarifies that the provision does not apply to veterinary medicinal products, plant protection products, fertilizers, seed for cultivation and packaging materials. (These are covered by other regulations that may impose more stringent traceability requirements.)

Regulation (EC) N° 178/2002 applies to all participants of the supply chain regardless of whether they take physical possession of the food or feed e.g. brokers must be considered as a form of supplier too. Although operators are not obliged to establish internal traceability by linking incoming and outgoing products, it would support more accurate identification of specific product batches in a fast manner, saving costs and time of recalls, and maintain consumer confidence. Delays of information delivery jeopardize prompt reactions.

The rapid alert system for food and feed (RASFF) had been established by EU Commission for the notification of risks to human health. In 2009, a total of 3322 original notifications were transmitted through the network, representing a 5.8 % increase versus previous years. Regarding cereals and bakery products genetically modified organisms (GMO) and

mycotoxins, for feed materials pathogenic microorganisms, foreign bodies, GMO, pesticide residues were the most often occurring risks.

Golan et al. (2000) examined the dimensions and objectives of traceability. The authors declare that none of traceability systems is complete. The amount of information collected defines the breadth of the system however recording all attributes of a product would be enormous, unnecessary, and expensive. Depth describes how far the system can track back or forward the relevant information. This may depend on where food safety hazards and remedies can enter the production chain. In specific cases safety measures need to be ensured at the farm level. Precision of the system is with what accuracy the system can pinpoint product movements or characteristics. The authors listed three objectives of traceability systems as improving supply management; facilitate traceback for food safety and quality; and differentiate and market foods undetectable quality attributes. The benefits of them are lower cost distribution systems, reduced expenses in terms of recalls, and expanded sales of products with attributes that are difficult to distinguish.

Moe (1998) distinguished four contexts of traceability:

- Product; it may relate materials, their origin,processing history, distribution and location after delivery.
- Data; it relates calculations and data generated throughout the quality loop, sometimes back to the requirements for quality.
- Calibration; it relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials
- IT and programming; it relates design and implementation back to the requirements for a system

The Food Standards Agency (FSA) of the United Kingdom (2002) suggests that traceability can be evaluated in audits for performance and speed, through a randomly selected product. The product must be identified back through the production and any products related through a common process. Having regular challenge tests to the traceability system is also critical. The most stringent requirement noted was full traceability back from delivery-to-customer to the supplier's raw material information in 2 hours. There is not an ideal system to cover the diverse needs of the food industry. Verification and assessment is according to the requirements of providing traceability back- and forwards, clear manufacturing windows are set for continuous production, the system includes all materials and ingredients and it gives response in appropriate time by providing readable traceability information to the customer.

FSA (2002) considers supplier assurance as a tool to minimize food quality and safety risks where traceability systems provide defense in case of crisis. In most cases suppliers submit a self-assessment, then they are audited before first delivery and re-audited regularly depending on the product and the risks, the size of orders, ingredient related customer complaints, and to assess the progress on requested changes at previous audits. For supplier selection the quality specifications are considered besides price as the outcome of the work of commercial and technical departments of the contracted parties.

The International Feed Safety Alliance (IFSA) published their Feed Ingredients Standard in 2005 providing guidance for traceability of raw materials and feed ingredients. It requires

traceability for each raw material and ingredient back to the point in the supply chain where the control of any hazards identified in risk assessments is neccessary. Even if the applicant does not hold all traceability records, capablility must be demonstrated to access the records if required. The applicant must record the names and addresses of raw materials suppliers, the type and quantity, dates of manufacture, batch numbers, unique identification reference of the transport and storage of incoming raw materials until the responsibility is passed to the buyer.

The European Feed Manufacturer's Federation (FEFAC) provided a detailed guideline in 2009 to good practices in the feed industry including traceability. Similarly to the requirements of legal and other frameworks, traceability data must include the name and address of all suppliers, batch numbers for purchased feed additives, nature and quantity of finished feed and their manufacturing date, name and address of the customers. Furthermore the registration number of suppliers (according to EU legislation) must be recorded too. The raw materials must conform to the required specifications, and controlled for known hazards according to a control plan (sampling procedure, frequency, analysis methods, actions in case of non-compliance) based on HACCP study and delivered by approved suppliers undergone an evaluation by the purchaser prior to the first delivery. There must be a documented, approved procedure for collecting traceability records, and it must be kept for the legally required minimum period of time in proper storage conditions preventing any damage to the records. These requirements need to be audited at least once a year by qualified personnel and non-compliances must be corrected.

GLOBAL G.A.P aims to establish a global standard for agricultural products that are capable of fitting to the globalizing agricultural market worldwide. Traceability, food safety and quality considerations related to compound feeds are key areas of assured animal production. GLOBAL G.A.P Compound Feed Manufacturing (CFM) Standard and a checklist summarize the most important control points and compliance criteria. The checklist contains 6 yes-no questions for documentation and traceability, each classified as 'major must' criteria. The questions include if the production process records maintained from feed ingredient selection to delivery to customers and capable of providing sufficient traceability and also, if feed ingredient records available upon arrival at the site within 14 days of delivery. There are a couple of general questions as well about each feed batch records being available and complete including medicated feeds. The high level approach in the CFM standard makes possible that feed producers can shape their systems according to their individual needs or local legislation, however the standard does not explain the criteria with recommendations for those who intend to improve their quality management system, supply chain or entire business operation further.

The International Food Standard (2004) requires on foundation level the establishment of a traceability system that enables the identification of product lots and their relation to ingredient batches, consumer unit packaging materials, processing and distribution records. Internal traceability system must be regularly tested with documentation up- and downstream between raw materials and product shipments including product reworks too. Traceability records must be kept for recall purposes for a defined period according to regulatory and customer requirements. Identified production samples to be stored appropriately and kept until the end of end-product shelf life.

Notermans and Beumer (2003) differentiated supplier traceability, process traceability, and customer traceability. Their interfaces must be managed with special attention to ensure

seamless traceability and introduction of an auditing system advised. For identification the lot was defined as a quantity of feed or feed ingredient produced and handled under uniform conditions, in a limited period of time, from identical ingredients, on a particular production line. The authors indicated general difficulties of traceability which are the labeling of products (if it cannot be physically labeled e.g. bulk materials), deciding on the lot size, separation of lots and stock management, mixing of feed, carry-over of ingredients from one batch to another and reprocessing of returned material.

3. MATERIALS AND METHODS

To assess traceability in the supply chain of a theoretical feed manufacturer, a traceability audit questionnaire has been compiled based on the legal requirements and other recommendations from standards that were referred to in the literature review section. The questions were grouped into 4 categories: ingredient to supplier, process at supplier, product to buyer, general traceability requirements at the supplier.

Table 1: Audit questionnaire for testing traceability

Nr.	Question
Ingredient to supplier (supplier traceability)	
1	Are risk assessments carried out for all feed ingredients?
2	Is there a risk based specification available for each ingredient?
3	Are the vendors audited frequently by the buyer company?
4	Are actions from audits defined and followed through for non-conformities?
5	Is there a procedure followed for supplier selection and approval and regular qualification (audits)?
6	Are the following data records kept for each ingredient batches?
7	*material name, type*
8	*name and address and status of supplier*
9	*batch size, amount, batch number (unique identification)*
10	*date of delivery*
11	*identification of vehicle or storage*
12	Is there a risk-based control plan defined and followed for incoming ingredient deliveries?
13	Is the sampling method, frequency, analytical methods followed as defined in a control plan for each ingredient?
14	Are the sample results compared to the limits defined in the relevant ingredient specification?
15	Is there a procedure followed to manage non-conforming ingredient batches?
Process at supplier (process traceability)	
16	Can be the traceability proved through process for each components?
17	Are the weighing certificates available for each product lots containing the components?
18	Are rework considered for traceability?
19	Is there a system to segregate production batches?
Product to buyer (Customer traceability)	
20	Are the following data records kept for each ingredient batches?
21	*material name, type*
22	*name and address of buyer*
23	*batch size, amount, batch number (unique identification)*
24	*date of delivery outbound*
25	*identification of vehicle or storage*
26	Is there a risk-based control plan defined and followed for finished products?
27	Is the sampling method, frequency, analytical methods followed as defined in a control plan for each finished product?

28	Are the sample results compared to the limits defined in the relevant finished product specification?
29	Is there a procedure followed to manage non-conforming product batches?
General traceability related requirements at the supplier	
30	Are the traceability records controlled?
31	Is a 24 hours contact available?
32	Are the traceability records stored at appropriate conditions?
33	How long are the traceability records kept?
34	How long does it take to carry out traceability tests upstream and downstream?
35	Is there a written procedure for product recall?
36	Is there a procedure followed that defines the frequency of internal audits?
37	Are the internal audits carried out by qualified personnel?

The audit questionnaire has been taken to and answered by 5 industrial companies dealing with cereal origin feed ingredients in Hungary. The firms have been also asked to carry out traceability tests both up- and downstream on a randomly selected product batch. The answers have been assessed as "adequate" or "non-adequate" and reported back to the relevant contact people.

4. RESULTS

All companies participating in the study had a traceability system that stored and maintained and linked ingredient and product records. 3 companies had a fully computer supported database system, while the other 2 applied the combination of paper documents and computer systems to trace the lots. All of the companies could effectively segregate batches and keep very similar records about ingredients, and the products too.

One of the differences between the companies was in the answers to Question 3. Even though all answered that they audit their suppliers, the frequency of the audits varied between 1-3 years. None of the companies particularly connected the audit frequency to the risk assessments for the ingredients (Question 1 and 2) that they indicated to carry out otherwise.

One company out of 5 said that there is no regular performance assessment for their suppliers, although they did not provide further details of reasons.

There were no particular concerns around the ingredient records and sampling, methods, and frequencies. Typically every ingredient batch that the companies receive from their contracted partners are sampled and analyzed for more or less parameters. Procedures to manage non-conforming ingredient lots were also in place. All questions in the process traceability and customer traceability sections got positive results too.

Question 33 asked the duration of traceability records kept at the company. The answers of participants varied between 2-6 years. Regarding the speed of demonstrating traceability of randomly selected product and ingredient lots, one of the companies was able to provide all necessary information in 30 minutes, while others needed from 1 to 4 hours that is considered to be an acceptable timeframe.

5. CONCLUSIONS

Traceability has a decade long history in the food and feed production chains. By now, most of the companies got familiar with the legal requirements, they are aware of the criteria and the ways how to reach them. Due to the fact that most of the partner companies buying the food or feed ingredients also follow strict rules of quality management, ingredient manufacturers are not only obliged to conform to quality standards, but they are also audited frequently on traceability too.

Other observation made during the study was that yes-no type questions in audits limit the opportunities to collect further information about the processes and standards of the companies above the minimum criteria. Therefore, when auditing traceability at companies, it is recommended to ask for examples or evidences beyond marking conformity to the standard when the answer is positive.

The results showed that traceability was possible at all companies both up- and downstream, the differences that occured was related to „how" they achieved conformity and what systems they built to support it.

If we consider that one of the objectives of traceability is to differentiate undetectable quality attributes of food (besides supporting the management of food safety issues) a fast traceability system may promote brand reputation. Connecting traceability and other important information from the supply chain about a particular food product and making it easily accessible to the consumer (e.g. on website by entering unique identification of the product), it may have a significant impact on the willingness to purchase and building trust. This case traceability brings value to the customer, but theoretically the producer and his vendors could get also direct information and build a robust database about final customers, their location, age, buying habits, social environment, interests in food information if the product information can be retrieved after personal registration to the web-based system (value to the producer).

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IMPACT STUDY OF TECHNOLOGICAL PARAMETERS USED IN LF PLANTS IN THE EFFICIENCY OF HYDROGEN REMOVAL

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ABSTRACT:

This paper aims, based on experimental data to determine the equation of correlation between treatment parameters LF steel plant type and yield of hydrogen removal. Experiments were conducted in a steel mill type electric furnace equipped with an EBT, installation LF and continuous casting plant. Treatment facility as parameters LF those of argon bubbling were considered next: bubbling duration, flow and pressure of argon, they were considered as independent parameters and as an independent parameter were considered hydrogen removal efficiency. Independent parameters were determined by measuring and control devices and the degree of hydrogen removal based on hydrogen content determined from samples of steel, taken before and after treatment with argon. The data were processed in Excel and MATLAB programs, which allowed obtaining simple and multiple correlation equations between the parameters chosen in the investigations. Based on the technological analysis of correlation equations, the optimum parameters change of bubbling was established. Results have practical applicability in developing steels.

Keywords:
Treatment parameters, LF steel plant, experimental data, hydrogen removal

1. THEORETICAL CONSIDERATIONS

During the process of making steel in electric ovens EBT There are different sources of hydrogen which, under certain conditions of pressure and temperature, make possible absorption of hydrogen in metal bath. From the experience accumulated from the operation of such furnaces and research conducted on a large number of batches produced, we mention that the main sources of hydrogen in all steel as follows:

- metal load humidity, as there is no technical possibility of drying the tippers loaded with scrap metal.
- the necessary additions to primary slag formation and slag from refining in the study because of the way supply (with 22 tons trucks) of lime and dolomitic lime, which during transport and storage whilst in the bunker, absorbing atmospheric humidity.
- the furnace atmosphere, because of the construction methods (panels, vault and other water-cooled elements) may appear accidental cases of breaking these elements and thus for short periods of time, but working with high pressure, cooling water enters the atmosphere to develop the aggregate.

The hydrogen dissolved in metal bath can be removed by secondary treatment of steel (or by bubbling with inert gas or by vacuum treatment of steel plants) [1,2]
Metal inert gas injection in the refining of steel melts for agitation and also refining, is a simple, widely applied method, by which gases are introduced, either on the bottom of the casting-treatment ladles – through a refractory porous plug or on the top of the pot with a

spear or also by submerged porous plug as deep into liquid steel, a process found in literature as the bubbling of the steels. Hydrodynamic action of the gas injected into the melt and formation during metal refining treatments other gases such as CO, CO2, N2 gas high expansion trend contributes to the vigorous mixing of melt. Specific mixing power and thus efficiency of metallurgical processes is dependent on specific parameters of the bubbling process. [3,4]
When inert gas is injected into liquid steel, hydrodynamic processes have as an essential feature the fact that the metal bath is in constant turbulent recirculatory motion. Qualitative and quantitative description of the areas formed in the molten metal at the injection of the gas, of the speed fields and the turbulence fields is a prerequisite condition for understanding the processes of mixing, dispersion and mass transfer and energy in these systems. [2]

2. INDUSTRIAL EXPERIMENTS

In the research program developed, there has been a detailed study of making the steel for the manufacture of pipes in industrial flow electric steel plant (furnace EBT) - secondary treatment facilities, continuous casting LF TC, the main directions followed being:

- determining and recording the level of hydrogen in liquid steel and on the finished product, steel bars for the manufacture of pipes;
- identifying the most important elements of hydrogen generators in liquid steel;
- industrial monitoring and recording all parameters that can influence the absorption or elimination of hydrogen in metal bath;
- modifying one technological parameter on the flow of industrial production, and study its influence on the hydrogen content of steel bath;
- Experiments were performed on a total of 25 batches at which were determined through successive measurements and recorded the following parameters:
- the quantity of the treated steel;
- the quantity of materials needed in LF slag formation and the quantities of ferroalloys;
- lime moisture;
- the chemical composition of the slag formed in L.F.;
- the hydrogen values at the beginning, during, and at the end of the treatment in LF plant;
- the bubbling gas parameters (flow and pressure);
- the total time of secondary treatment and the time of steel standing in the casting ladle;

The data were analyzed in technological terms and eliminated those where different technological deviations were found (measurement errors, human factor interventions).

3. EXPERIMENTAL RESULTS

Data processing was done in MATLAB and Excel programs, results are presented both graphically and analytically.
The graphs below are presented the influence of bubbling parameters on the efficiency of removal of hydrogen during secondary treatment.

In Figure 1 there can be observed a significant dependence (with a correlation coefficient R2 = 0.8879) between the variation of argon pressure and increasing the efficiency of hydrogen removal during secondary treatment. Correlation curve shows a maximum pressure of 4.31 bar, point situated in the technological limits of variation of argon pressure.

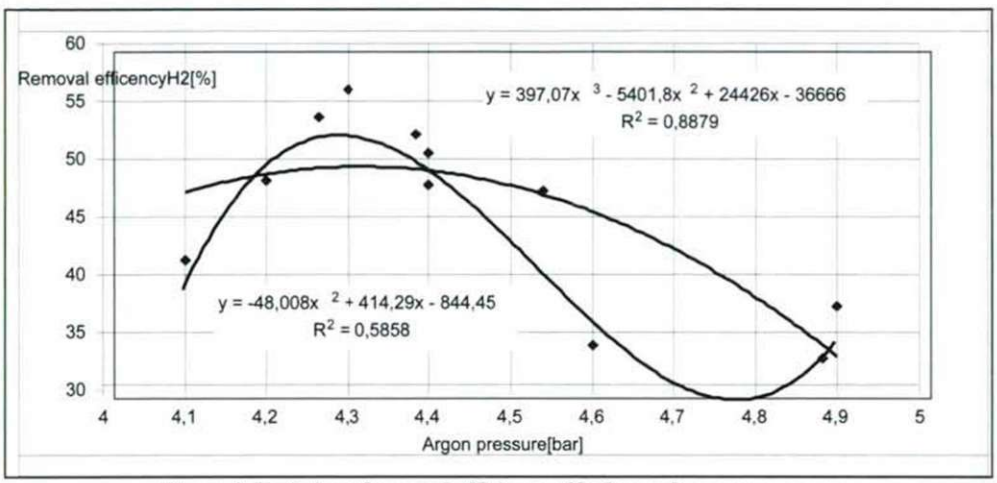

Figure 1. Variation of removal efficiency of hydrogen by argon pressure

Analyzing the graph, shown in the figure above we consider suitable for bubbling pressures lie within 4.1 to 4.5 bars. At lower pressures the bubbles have a lower speed, so a lower quantity of hydrogen will be removed. At higher pressures, the steel in the ladle can remain uncovered (without slag), which would allow an increase through absorption of hydrogen dissolved in steel.

In Figure 2 it is underlined the argon flow influence on yield variation of removal of hydrogen during secondary treatment.

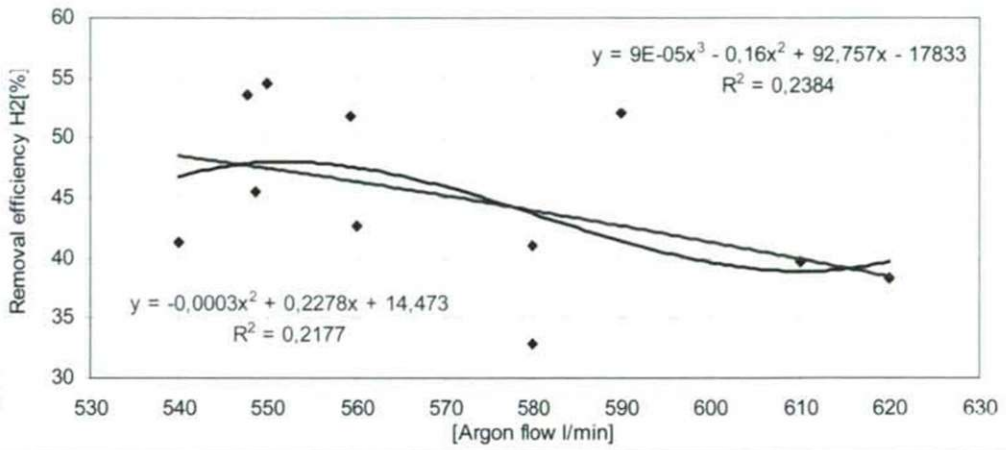

Figure 2. Variation of removal efficiency of hydrogen by argon flow

From the figure above it appears that, if the argon flow values between 540 and 570 l / min, hydrogen removal efficiency varies between 45 -50%. An increased flow of oxygen as a result of increasing pressure leads to a slight decrease in the efficiency of hydrogen removal, a phenomenon caused by hydrogen absorption in steel bath due to the fact that it remains uncovered by slag.

Another influential parameter is the length of the bubbling - fig.3.

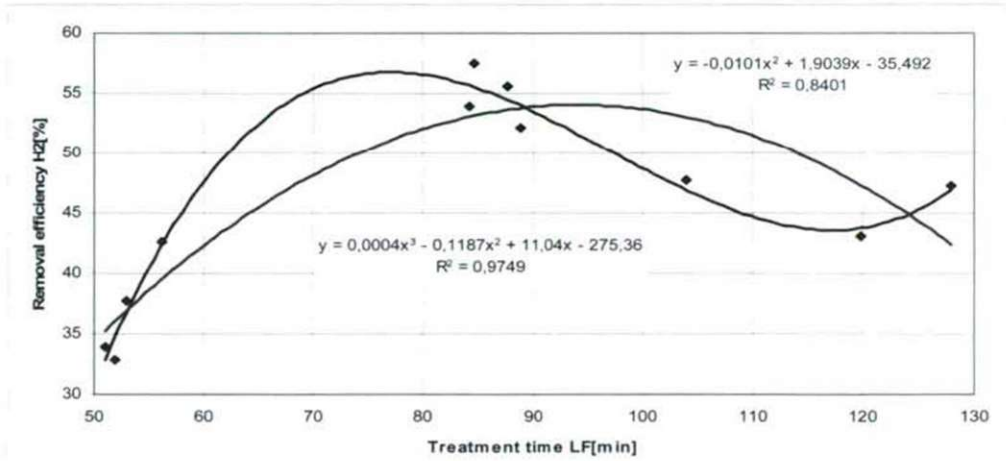

Figure 3. Variation of hydrogen removal efficiency depending on the length of argon bubbling

As it results from the chart shown in Figure 3, the secondary treatment duration has a decisive influence on the efficiency of removal of hydrogen, the ideal duration of treatment is between 85 and 105 minutes.

Next the results obtained in the case of multiple correlation $\eta H = f(Tb, Db, Pb)$ are shown. Since we can not graphically represent (in the space of four dimensions) such correlation, the

equation with three independent parameters, through permutations we assigned to a parameter the medium value so we got equations with two independent parameters, the equation can be graphically represented in the space with three dimensions. Obviously we can get directly from the processing of the data the equation with two independent parameters, but we wanted to obtain an equation with three independent parameters.
The correlation equation with three independent parameters is of the form:

$$\eta_{H2}= 5{,}503\cdot10^{-3}\cdot D_b^2 + 21{,}1831\cdot P_b^2 - 2{,}846\cdot10^{-3}\cdot T_b^2 + 1{,}7275\cdot10^{-3}\cdot D_b\cdot P_b$$
$$-3{,}3\cdot10^{-2}\cdot P_b\cdot T_b - 2{,}444\cdot10^{-4}\cdot T_b\cdot D_b - 6{,}2556\cdot D_b - 188\cdot P_b + 1{,}014\cdot T_b + 2{,}195\cdot10^{3} \quad (1)$$

The correlation coefficient R= 0,7147. The saddle point coordinates: Db = 570,5209; P_b = 4,5198; T_b = 127,4225; η_{H2} = 49,7965
Substituting into equation (1) for Pb = Pbmed it results an equation (2) of the form:

$$\eta_{H2}= 5{,}503\cdot10^{-3}\cdot D_b^2 - 2{,}846\cdot10^{-3}\cdot T_b^2 - 2{,}444\cdot10^{-4}\cdot T_b\cdot D_b - 6{,}248\cdot D_b + 0{,}868\cdot T_b + 1776{,}86 \quad (2)$$

Figure 4 show that the correlation surface presents a saddle point in the technological field. For the hydrogen removal yield, the medium value is ηmed = 46.8215.
To obtain higher values for a value near the saddle point, for example over 48%,the values for two independent TB parameters Db must vary so that ηH2 values are always located in the area hatched.
It has been found that the highest values for ηH2 are obtained to the upper limits of TB and DB. For db = Dmed equation (1) has the form:

$$\eta_{H2}= 21{,}1831\cdot P_b^2 - 2{,}846\cdot10^{-3}\cdot T_b^2 - 3{,}3\cdot10^{-2}\cdot P_b\cdot T_b - 87{,}28\cdot P_b + 0{,}874\cdot T_b + 4{,}174\cdot10^{2} \quad (3)$$

Correlation surface is shown in Figure 5, from the surface analysis it results that higher values of ηH2 are obtained as in the previous case for values of Tb to the upper limit. Regarding Pb, higher values for ηH2 are obtained for extreme values of this parameter. For the supreme value of ηH2, we must be situated in the field hatched.

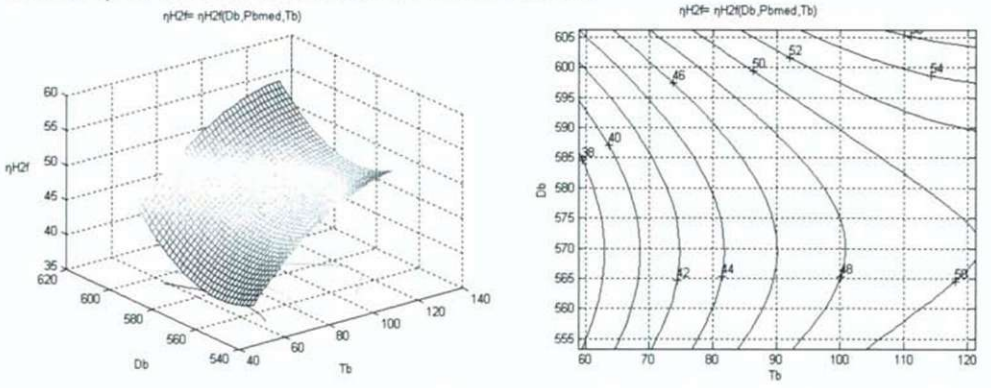

Fig.4.The Influence of argon flow and duration of bubbling in the removal of hydrogen yield

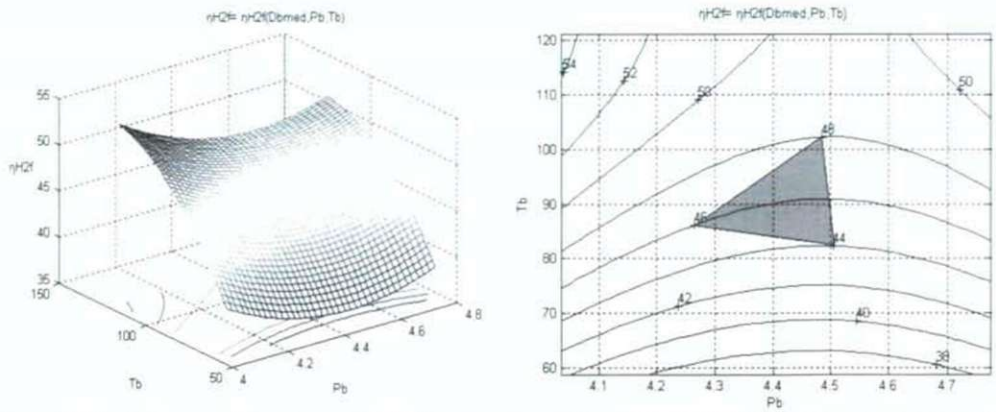

Figure 5. The influence of duration and bubbling pressure on the yield of dehydrogenation at an average flow of inert gas

From Figure 6 it results that at a flow of 560-580 N m 3 / h and a pressure of 4.35 to 4.65 bar of the bubbling gas, metal bath is found favoring the absorption of hydrogen in the atmosphere. Under pressure of 4.5 bar and at a higher rate because the metal bath remains discovered and the contact between the steel and gas bubbling is more intense, that hydrogen diffusion in steel argon bubbles occurs at much higher parameters, a high dehydrogenation level of steel occurs.

For the average duration of bubbling Tb = Tb med. equation (1) becomes:

$$\eta_{H2}=5{,}503\cdot10^{-3}\cdot D_b^2 + 21{,}1831\cdot P_b^2 + 1{,}7275\cdot10^{-3}\cdot D_b\cdot P_b - 6{,}275\cdot D_b - 190{,}93\cdot P_b + 2{,}258\cdot10^3 \quad (4)$$

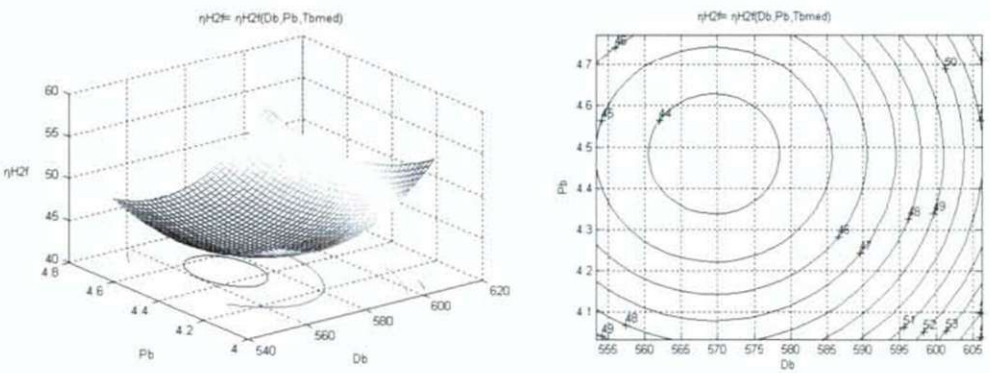

Figure 6. The influence of flow and bubbling pressure on the yield of dehydrogenation at an average duration of bubbling

4. CONCLUSIONS

The quality of finished steel products may be influenced by hydrogen content of liquid steel. Therefore, in the literature are presented many methods and processes of dehydrogenation of steel, but the selection of optimal variant must be made in correlation with specific technological characteristics of the technological flow, as well as in conditions of maximum economic efficiency.

The investigations carried out have resulted in a number of conclusions with practical application, namely:

- between the parameters of the steel bubbling with argon and hydrogen yield there can be established significant correlation equations both mathematically and technologically;
- the equations obtained in Excel program allow the determination for the independent parameters of some the limits of variation for these values;
- the multiple correlation equations, determining the variation fields of the bubbling parameters, given their complex influence;
- by getting the range of variation of the bubbling parameters there can be obtained improved values for the degree of removal of hydrogen.

ACKNOWLEDGMENT

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REDUCTION OF WATER CONSUMPTION FOR SUSTAINABLE WATER MANAGEMENT

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ABSTRACT

As a result of climate change extreme weather and river flow events are projected to become more frequent, experts say. The regional, time and quantitative distribution of precipitation is expected to change, which through the flow of rivers affect groundwater supplies, being one of our major sources of water supply. Therefore water management should be given a priority role among activities aiming at the preparation for climate change. A means of it is the re-evaluation of our current water use patterns and the reduction of water consumption of all concerned in their own context.

1. INTRODUCTION

The three most important but only partially renewable resources on the Earth are water, energy and food. Water supply directly affects all three areas, so caution must be taken when water management principles and practical steps are considered and implemented. In order to make essential healthy drinking water available for the generations after us in quantities to cover at least their basic needs, we must avoid the overexploitation of water resources and in many cases we need to reassess current water use patterns. Thus sustainability should be interpreted as the coordination of ecological and economic considerations (where the economic standpoint cannot necessarily aim to maintain or raise the pace of today's economic growth). The protection of the quantity and quality of drinking water is not only justified by the finite quantity of water resources, but also by the energy intensity of water supply: if you consume less water, in conjunction with it the energy consumption is also reduced. In addition, examining the full range of water supply –including drainage, too– applying some modern technologies, energy can be gained from the process, which can be either used to reduce the energy demand of water supply or to be utilized for other purposes.

2. FACTORS DETERMINING WATER MANAGEMENT IN HUNGARY

Hungary is a country rich in both surface and underground water resources. This is due to its geographical location: in the middle of the Carpathian Basin, on the base level of its rivers around, largely circumscribed by the Alps and the Carpathians, with the rivers flowing here. These surface water flows provide favourable conditions further strengthened by excellent soils for agricultural cultivation. This feature may get even more advantageous over time due to weather extremes and general drying caused by presumptive climate fluctuation, scientists say. To better utilize this advantage also implies the modification of water management concepts, with more close-to-nature solutions to water management and with stilled

permeation of streams, as well as with the reconsideration whether dams are the only solution to flood prevention (Glatz 2002).
Hungary's already mentioned "water luring" position is accompanied by the risky consequence that the quantity and quality of water coming from other countries are heavily dependant on the state and conditions of the surrounding countries, their economic and nature shaping activities, etc. Water management, therefore, is determined by a regional nature – above average in Hungary.
Most of Hungary's surface waters do not show their original, natural state but are significantly regulated. This situation started off on a large scale with the regulation of the River Tisza, which was the time when the largely technology-driven drainage system evolved. In today's water management besides its technological nature the ecological approach is also picking up strength (Varga, M. 2009), in the pursuit of long-term protection of water quantity and quality. I intend to briefly expand on a few possibilities hereinafter.

3. SUSTAINABILITY OF WATER SUPPLY

Total costs of both the investment and operation of today's water supply networks (purified pipe-line drinking water provided for consumers and subsequently closed-channel sewage and rainwater drainage, sewage treatment, disposal into natural recipients) rank the highest among all urban infrastructure networks. Economic sustainability of these networks is enhanced by any technical solution that allows for reduced costs. The pursuit of ecological sustainability aims at the protection of the quantity or quality of water used. Such a modern approach can be applied by both water service companies and water users.

3.1. Sustainable water supply on the water suppliers' side

When making use of natural resources, we should pursue the combination and coordination of both the engineering and the ecological aspects of sustainability. Perhaps the greatest difficulty with these two approaches is the two different space and time scale thereof (Somlyódy 2000). The ecologist sees long-term consequences of development decisions, but society calculates with short-term benefits and expects that developments as well as engineering work are conform to them. The way an engineer can reconcile the two is to incorporate feedbacks into the systems set up, on the basis of which operation of the systems can be corrected.
A problem of water supply both in our natural and built environments is that the spatial and temporal distribution of water resources vastly differ from needs. Due to climate fluctuation extreme water flows are expected to grow, both in respect of quantity and frequency. A sustainable solution should be found to this in water supply. By reducing water consumption we by all means move towards sustainability. To do this, in some cases, the normal water supply infrastructure is to be reconsidered. Analysing the utilisation of waste water, we can conclude that about half of the pipeline drinking water could be replaced by water meeting less stringent requirements but produced more cheaply. This could be rain or the so called "grey water" (once used but low-contaminated waste water). This would require a differing

development of sewerage systems from the present ones. However, a number of energy-saving solutions could also be implemented alongside the existing water supply system.
These are usually based on the decrease of pumping electricity demand during extraction of water, its transportation and storage (because of the time difference of stock and needs arising), by using advanced, tailor-made pumps with adjustable power and pumping consumption capabilities. The electricity-saving potential is best characterized by the fact that in 2001 20% of the world's energy intake was assigned to the propulsion of pumps (Eördöghné 2008). To lessen the aversion to economical solutions we find it essential to make users realize that this and the majority of the solutions further discussed do not bring about any reduction in the current feeling of comfort.
Water consumption could be further reduced by the diminished volume of water loss is the pipeline system (this amounts to about 25% in Hungary, rating us in Europe's mid-range). Due to leaks in the water supply networks the entire planet loses 45 million m^3 water on a daily basis - approximately the water demand of roughly 200 million people (World Bank 2006 data - in Grundfos). A major source of this loss is due to pipeline failures, leaks, and the long time that elapses until these problems are located. The cause of pipeline failure in many cases is the pressure surge in the network itself, in the form of mechanical stress on the material of the pipeline (see Figure 1). To tackle this problem a novel idea is under trial/development, which targets to keep the pressure of the pipeline system low outside peak periods thus trying to reduce the harmful effects of surge, or in case of existing leaks to reduce the "driving force" of runoffs. Keeping water pressure low is also beneficial on the consumption side of the network as it can facilitate lower water consumption.

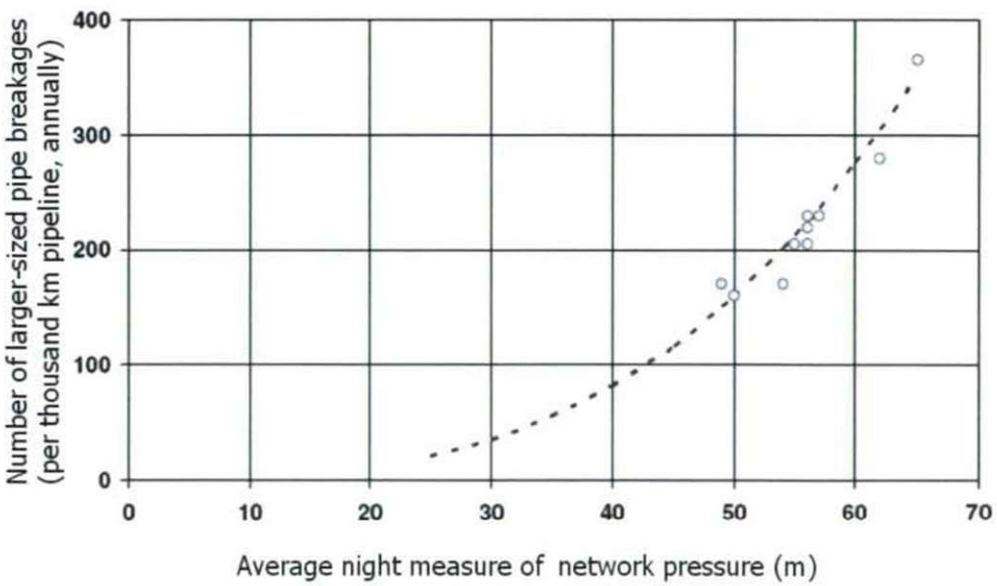

Figure 1. Impact of water pipe pressures on the frequency of pipe breakage (source: Grundfos)

In the second phase of water supply, in sewage disposal, most of the energy demand is represented by the electric propulsion of the aeration equipment used in wastewater treatment plants to speed up the degradation process. This can also be reduced by less water consumption (which, as a consequence, further reduces the volume of waste water to be treated) as well as by managing rainwater separately, ideally utilising it in situ.
We could also gain energy from sewage disposal, thinking of the utilisation of the caloric content of waste water by heat pumps (as several operating devices demonstrate it in Germany, Switzerland, see Figure 2.), or the use of gases during waste water treatment e.g. in gas engines.

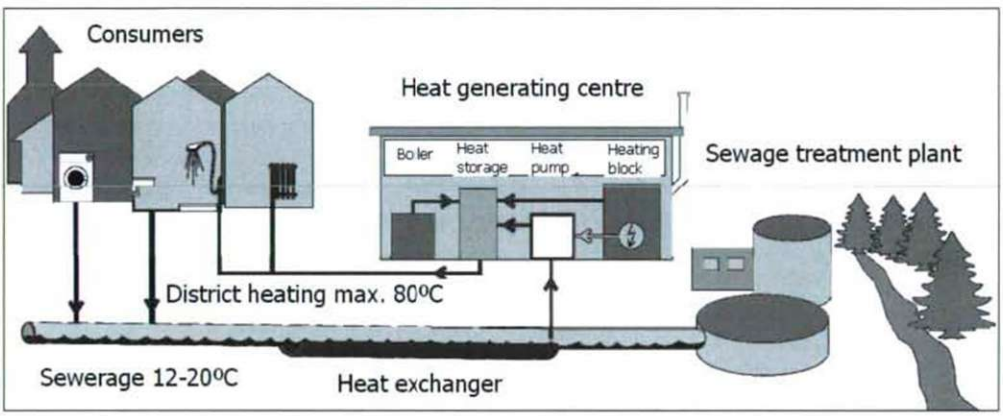

Figure 2. Utilisation of the caloric content of waste water by heat pumps (source: POP 2009)

Among water saving opportunities on the water suppliers' side we should not forget to mention thermal water recovery –both as water and as energy– in Hungary. Here it is worth examining the exploitation of thermal water whenever designing the energy resources for heating and providing running hot water for certain establishments or when choosing appropriate energy resources for other technological purposes.
A great number of investments attest the energy efficiency of thermal water recovery, but there is a lot of headway to be made and a lot of R&D activities are still required in this topic.

3.2. Potentials of water users in their sustainability efforts

If we seek the most efficient incentive to encourage water saving, we will eventually get to ethical issues. Apart from the price level of water, the most reasonable explanations, the availability of water saving instruments, it is also the ethical attitude towards the assessment of the needs of other customers (including those of future generations). Unfortunately, this area still offers a lot to do. Simultaneously with forming attitudes and environmental awareness of consumers, we should familiarize them with such technical solutions that can contribute to the sustainability of water supply. At today's level of environmental awareness we may say that

perhaps the most effective means of encouraging reductions in water consumption is the price of water (see Figure 3).

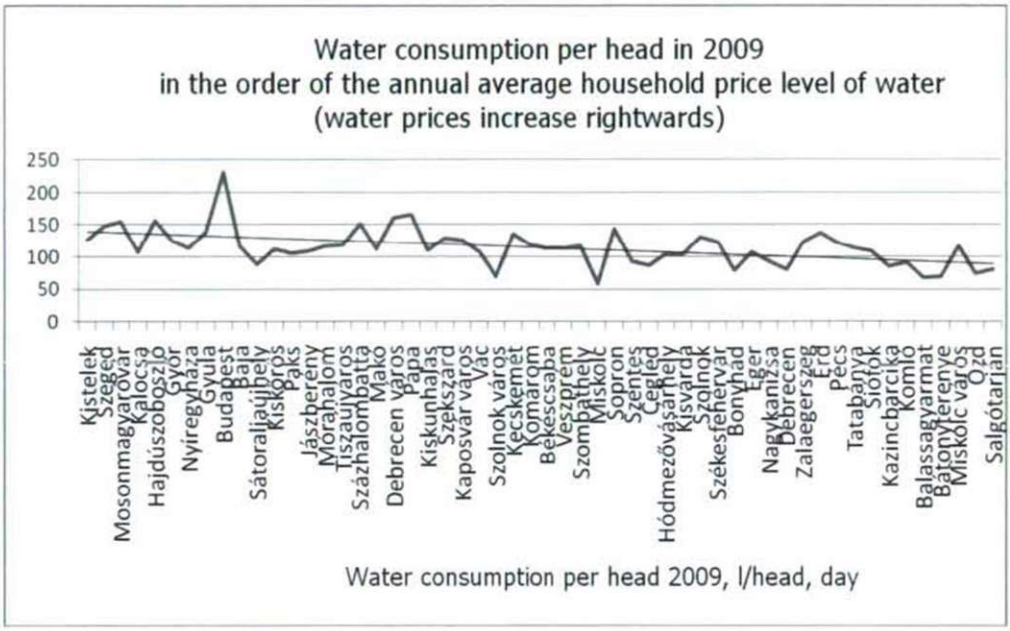

Figure 3. Impact of price level of water on the volume of water consumption (own construction)

In case of households water-saving solutions can be classified into four categories:

- changing patterns of water consumption
- application of technical water-saving devices
- use of alternative water sources
- use of alternatively designed sanitation systems

These options can be the most effective when complementing each other. Spreading general awareness of them requires a lot of dissemination efforts in the fields of education, social and individual attitudes.

The first practical step towards the reduction of water consumption is to identify those areas where currently we waste most our of drinking water (in an unjustified way) (e.g. toilet flushing, cleaning, garden watering, and a range of water demand, where no drinking water quality would be required). The majority of these could be covered by the more environmentally conscious solution – use of rain or grey water (e.g. washing machine's water for washing used for flushing toilets), since it would actually decrease the amount of water extracted from the environment (whereas using one's own wells would only reduce the amount of the water bill). The modernity of water consumption fixtures also significantly influences the amount of water used (e.g. water faucets with air stirred in make an impression of taking more water, etc.). In public institutions where cost sensitivity is lower towards the price of water it is appropriate to use self-closing or timed faucets. Even more attention should

be paid for the quantity of hot water consumption due to its higher production costs, e.g. by installing thermostatic mixer taps or circular network design.

Today's system of water use – indoor plumbing and closed-channel drainage followed by sewage treatment – results in very high specific water consumption. As a response to it environmentally conscious solutions have been developed such as dry, otherwise known as composting toilets, the separated drain-off (separator) toilets or anhydrous urinals.

The applications of these systems apart from protecting water resources also carries the advantage that by treating waste water of physiological origin separately, nutrient management may become more favourable: utilising the N, P content of waste water may decrease the synthetically produced N, P quantity.

Dry toilets operate without water flushing and are placed inside the building. The faecal accumulates in a ventilated composting chamber together with wood chips added after use of the toilet. Organic household waste can also be deposited in this container. Composting is performed by soil bacteria to be found at the bottom the chamber, resident in the thin layer of topsoil. Such bacteria need oxygen and cellulose for their vital functions, the former is provided by ventilation, the latter by the wood chips. Composting takes place at temperatures around 60-70 °C, which kills pathogens. The decay lasts 1.5-2 years; the end-product is odourless, sterile humus.

The use of dry toilets will reduce water consumption and sewage load approx. by 35%, and also, about 40% less household waste is produced.

The bowl of the separating toilet (Figure 4.) is divided into two parts, with separate flushing systems. The faecal gets down the drains, the urine (with minimum water flushing) gets into a plastic container. Storing the urine in this plastic container for at least 6-9 months we get a soil nutritive substance suitable for substituting potassium, phosphorus- and nitrogen-containing fertilizers, thus decreasing their production and use (GayerJ. – F. Ligetvári 2007). The technology developed ensures odourless operation with a one-time emptying of the container in a year. The amount of water used for flushing is decreased by nearly 80%.

Figure 4. The bowl of the separate drain-off (separating) toilet (Novaquatis)

The special surface of non-flush pissoirs is made of polyester fibreglass, which is water repellent, so no flushing is required. The siphons contain biodegradable sealant liquid, the density of which is lower than that of water, so the fluid flows through it smoothly. Apart from the saving in flush water it is an additional positive feature that there is no acid cleaning of the toilet that would also damage the environment.

To convert water use patterns into sustainable ones is mainly at the disposal of consumers that live in areas with no sewer. In such cases, the locally applied, natural wastewater treatment solutions can be offered. Different wastewater treatment plants (wetlands, lakes, etc.) use natural processes to treat sewage-water. Bacteria break down the organic matter of the sewage, using oxygen for their functioning. This oxygen is provided by the intermediary plant. A significant portion of the purified water evaporates; the rest gets back into ground water or running waters.

4. CONCLUSION

Among the strategic measures to be taken regarding climate-change, an enhanced role should be attributed to water management. Ecologically sustainable water supply means to protect drinking water both quantitatively and qualitatively.
This analysis presents some possibilities thereof, drawing attention to the fact that a common feature of all sustainability efforts lies in cooperation: "cooperation" between man and nature, and cooperation between experts in different professional fields.

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STUDY OF COMBINED MICROWAVE VACUUM DRYING OF APPLE RAW MATERIAL

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ABSTRACT

A widespread and simple method for preserving fruits and vegetables is drying. Hot-air-, freeze-, vacuum- and dielectric drying are the most common methods. In this work, the microwave-vacuum drying combined with hot-air pre-drying was investigated for apple. This combined drying method produces a snack-like product with crisp and puffed structure, preferred by consumers. It can be an alternative to products like deep-fried potato, or fruit chips. The ovary of the raw apple was removed, and then the apple was cut into slices. After the preparation, the sample was hot-air dried, and then microwave vacuum-dried for 60, 70 or 80% and 97-98% dry basis, respectively. During microwave vacuum drying, the rapid evaporation of residual moisture of raw material causes the fruit tissue to expand, creating a porous crunchy texture with low mass density. In the course of the drying process, pulsed microwave energy is used, with radiation, and relaxation times. The microwave energy is provided by two magnetrons, with severally 850Watts nominal, 450Watts effective output.

Our aim is to investigate the technology-related properties of microwave vacuum drying combined with hot-air pre-drying. The experimental pilot plan consists of 3 independent variables (factors) and 2 dependent variables. The mass load of the pre-dried fruit was 200g and the applied vacuum was 50 mbar. The independent factors were investigated in 3 levels: pre-dried dry mass content, (60, 70, 80%) the specific energy input (12, 14, 16 minutes of total microwave radiation, which equals 1.62, 1.89, 2.16 kJ/g specific energy) and the ratio of double-magnetron treatment and total radiation. (0.5, 0.75, 1) Two of the product's measurable properties as dependent parameters were analyzed; the burning ratio and the mass density. Our goal was to create product with minimal burning ratio and minimal mass density.

After performing the experiments, the following conclusions can be taken. The mass density and the burning ratio of treated apple are directly proportional to the energy input. Within the studied range, at low initial dry matter content of the pre-dried product (60% dry matter content) with intense energy input, desirable product can be achieved. The ultimate optimum occurs at medium initial dry matter content (70%), 0.8 double magnetron-treatment ratio, and 1.755 kJ/g energy radiation.

1. INTRODUCTION

Dried food products have always had stable marketability, and nowadays the demand for these dried food products is continuously growing. With new technologies, it is possible to create new dried products, with unique characteristics, excellent rehydration rate, sensorally preferred properties, and high nutrition value. These methods are expected to be energy efficient, and rapid. Most commonly used technologies for drying are hot-air drying, freeze drying, osmotic dehydration, microwave-, and vacuum drying. Using these methods in

different combinations can result advantageous properties, for example higher drying rate, or increased quality product.
The microwave vacuum drying (MVD) is a rapid and efficient dehydration method, which can yield unique characteristics, improved product appearance and quality, compared to conventionally dried products. This improved quality is achieved by the combination of microwave energy and vacuum. The electromagnetic microwave radiation penetrates the interior of the food, where it is converted to thermal energy and causes rapid warming. However, the vacuum reduces the boiling point of water, keeping the product temperature low, as well as creating a pressure gradient that enhances the drying rate. The microwave vacuum drying is less time-consuming, compared to air-and freeze-drying, which can take up to several days. The microwave radiation is being applied cyclically, with moderately strong vacuum, which results in better product quality and energy efficiency. The unique, crispy, open cellular structure of the dried product, related to MVD is created by an expansive force by the *in situ* vaporization of water. Because of the low temperature, and the low oxygen pressure during the drying process, higher degree of remained nutritional and aromatic components sensitive to oxidation and thermal degradation can be achieved than by air-drying. Although, the investment, operating and energy costs of microwave-vacuum drying are higher than the conventional air-drying costs, the higher quality end product results greater benefit. The microwave vacuum driers use more electric energy than the conventional hot-air driers; however, the efficiency of the microwave vacuum drying is better, especially towards the end of the drying process. This motives the spreading usage of new combination drying processes, such as MVD combined with hot-air drying. There is a research and development project takes place in this topic in the Central Food Research Institute. Because of the regularities of atmospheric hot-air-drying are thoroughly explored, this article deals primarily with the MVD operation within the combined process.

2. MICROWAVE VACUUM DRYING

2.1 Microwave properties

Microwaves are electromagnetic radiation with frequencies from 300 MHz to 300 GHz, and wavelengths from 1 mm to 1 m. Two designated and approved frequency is used for heating in households and industry, 915 and 2450 MHz. The electromagnetic waves react in different ways with the objects encountered; they are reflected from metallic substances, absorbed by some dielectric material, or transmitted without significant absorption. Water, carbon and high moisture-content materials are good microwave absorbers, while glass, ceramic and most thermoplastic materials let the waves pass through them with negligible absorption.
Microwaves can be created by different devices, but magnetrons are used almost exclusively in the industrial and the culinary practice.
Microwaves don't carry real heat, but as the electromagnetic radiation with rapidly changing polarity contacts with the food material, the microwave energy transforms into kinetic energy, then heat. The electromagnetic field of the microwaves affects the ionic-, and also the polar/dipolar molecules. It forces the ionic compounds to accelerate in the direction of the field, while the polar components start to vibrate due to the changing polarity of the electromagnetic field. This is how the microwaves' energy dissipates. The friction of these moving compounds generates heat, which is equalized by conduction.

Water is a constantly present molecule in foodstuff in large quantities. It is good microwave absorber, because of its permanent dipole. The absorption rate depends on the physical-chemical status of water molecules. Free water bonds to each other with hydrogen bonds, which is easily broken by microwaves. The dipole rotation of water molecules bond to peptides, or carbohydrates is inhibited, so the absorption of microwaves is much less.
In the case microwaves approaches the food from several directions, inner reflections can come up, thus the energy of the rays adds and „hot spots" are created. Hot spots cause inhomogeneous heating and increasing chance of damaging the product. Hot spots can be avoided by moving the sample, or increasing the homogeneity of the field, but the latter is a difficult and complex task.

2.2 Properties of microwave vacuum drying

Drying rate

At foodstuff, the simultaneous usage of microwaves and vacuum causes faster drying rate compared to conventional drying methods, because of the same direction of heat-, and mass transfer. The process of MVD can be divided into three periods.
At the beginning, the microwave radiation almost completely turns into heat, causing continuously warming sample. The warming keeps going until the boiling point of the water, which is determined by the ambient pressure. The evaporation in this period is negligible. Compared to the hot-air drying, this phase is very rapid. The next period is the drying. The temperature of the sample is approximately constant, while the energy of radiation is being consumed by the moisture evaporation. During hot-air drying, the dying rate decreases continuously, while the MVD has no, or minimal drying rate reduction. The third period is characterized by decreasing intensity drying. The drying rate decreases, while the more strongly bond water also leaves the sample. In the conventional hot-air drying method, this is the most time-consuming period, taking away two-thirds of the total drying time. MVD has two significant advantages in this period: most of the moisture leaves in the isothermal period, and the diffusion of the evaporated moisture inside the sample is much faster than the diffusion of liquid moisture.
During MVD, the drying rate is affected by the total irradiated energy, the applied vacuum value, the sample mass is the vacuum chamber and their relations. High energy input and low pressure increases the rate of mass transfer, thus the drying rate, while more weight of sample per treatment decreases the drying rate.

Quality of product

With microwave vacuum drying, a popular crunchy product with puffy texture and low mass density can be created. It is suitable for direct consumption as a smack, or can be consumed after storage and rehydration. The texture is created by the overheated moisture, which caused by microwave heating, and reduced boiling temperature by the vacuum. Steam is generated inside the material, which creates inner pressure, thus the puffing of the product. During drying, this process is somewhat controllable, because the strength of the structure-keeping force depends on the evaporation rate (thus indirectly on the energy input) and the pressure of the vacuum chamber. This puffing phenomenon occurs more intensively when the MVD process is preceded by hot-air drying.

Other advantage of the MVD over traditional drying methods is the greater retention of bioactive components of foods, for example antioxidants or vitamins, which are – as is well known – easily inactivated by oxidation or thermal degradation.
Attention should be paid to the smooth heat treatment and the drainage of the generated vapor. Their absence could result in unfavorable burning. The phenomenon starts with browning, presumably the Maillard-reaction, but finally results burnt, inedible products. The burning always starts from the inner material, reaching the surface only in a few cases, makes it hard to sense. The burning of the product can be avoided by moving the sample during drying, reducing its size, or reducing the intensity of the microwave energy.

Economy
Experience suggests that the investment-, operating-, and energy costs are higher at a microwave vacuum drying equipment, than a hot-air dryer. MVD requires more energy, but the energy is used more efficiently, especially at the end of the process. For the economical and quality production, it is important to determine the optimum point for the microwave energy, and the applied vacuum. With this knowledge in possession, the energy usage for MVD can be lower than the hot-air drying. The ideal combination of these two drying processes also decreases the overall energy consumption for drying.

Combined drying method
For the fruits and vegetables, there is a critical point of dry mass content during drying. If the moisture content is removed by conventional drying until this point, where only the free water leaves the sample, then the quality parameters of the product doesn't change. So, the combination of hot-air-, and microwave vacuum drying is more energy-efficient, and creates better quality product than using the technologies alone.

The aim of this present work was to study the effect of MVD parameters, in microwave vacuum combined drying process combined with hot-air drying, namely microwave power, intensity and initial dry matter content on the products burning ratio and mass density, and to determine optimum values for obtaining high-quality dried apple chips.

3. MATERIALS AND METHODS

3.1 Raw material and drying preparations
As raw material, Jonathan apple was used, because of its pleasant aroma and prosperous puffing tendency. The ovary of the apple was removed and then cut into 8mm thick slices. Pre-drying operation was done by a laboratory-scale hot-air drying equipment. The pre-drying was done until 60, 70 or 80% dry matter content.
The microwave vacuum drying equipment has a cylindrical stainless steel vacuum chamber, with a conical dome for better vapor removal. The samples are hold in a rotary teflon tray. Microwaves are generated by two, 850W nominal efficiency magnetrons. The vacuum is kept constant at 50 mbar by a vacuum pump, connected to the heat exchanger for vapor condensation. The cooling water for the heat exchanger is cooled by a compressor and kept circulating by a pump. For each treatment, 200 grams of pre-dried apple was dried. Intensive

radiation was used in the beginning of the treatment, and then the intensity was continuously reduced. The radiation (active) and relaxation (passive) time was equal.

3.2 Experimental design

For the experimental design, 3 independent variables with 3 levels, and 2 dependent variables were used. The independent variables (factors) was the dry mass content of the pre-dried sample, (at 60, 70, 80%) the specific amount of energy irradiated (12, 14, 16 minutes of magnetron radiation) and the ratio of double magnetron-minutes and total magnetron-minutes (intensity) (0.5, 0.75, 1). The dependent variables were the burning ratio and the mass density of the product. These two quality parameters can determine the sufficiency of the treatment. For better quality product, lower mass density and lower burning ratio is desirable.
Box-Behnken experimental design was used. The changing of the independent variables (factors) causes the changing of the two quality variables; these correlations were evaluated. Quadratic model was used with interactions.

3.3 Measurement

The determination of the moisture content was done by a KERN MLB 50-3 type rapid moisture content analyzer.
The burning ratio was calculated from the weight of the burned pieces, divided by the weight of all pieces in one treatment cycle.
The mass density was measured via volume-displacement method, with mustard seeds.

4. RESULTS AND DISCUSSION

4.1 Burning ratio analysis

The results of the burning ratio are shown in figure 1.

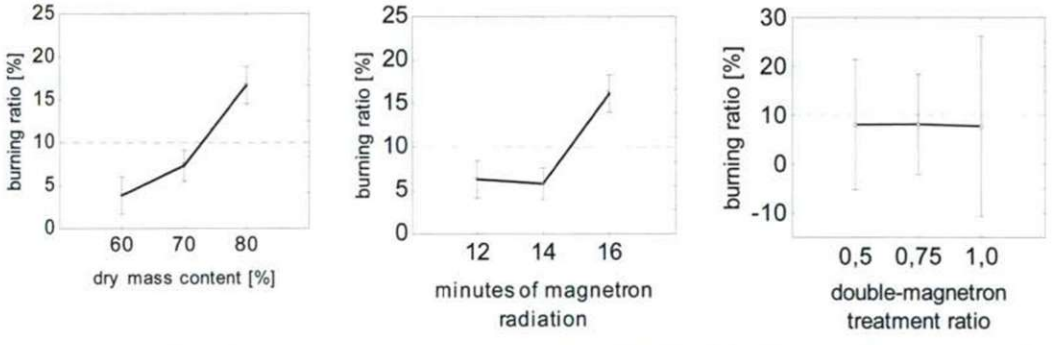

Figure 1. Burning ratio over dry mass content, magnetron-minutes and double-magnetron treatment ratio

Increasing dry mass content and increasing magnetron-minutes also results increasing burning ratio. The double-magnetron treatment ratio has no significant effect on the burning ratio due to its high standard deviation. Technologically acceptable burning ratio is determined at 10%, shown in Figure 1 with a red dashed line.

4.2 Mass density analysis

The results of the mass density are shown in figure 2.

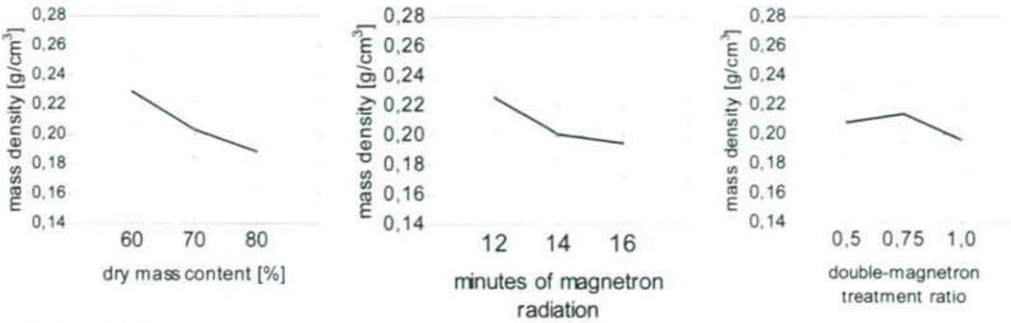

Figure 2. Mass density over dry mass content, magnetron-minutes and double-magnetron treatment ratio

Increasing dry mass content and increasing magnetron-minutes results decreasing mass density. The double magnetron treatment ratio has no significant effect on mass density. The desirable lowest mass density occurs at the maximum of the two parameters, but every product is acceptable under 0.2 g/cm^3. This acceptance limit is shown in Figure 2 with a red dashed line. From this point of view, similar quality product can be achieved by different combinations of treatment time and pre-dried sample mass content.

4.3 Combined analysis

At the maximum values of the two significant parameters, the magnetron-minutes and the dry mass content of the pre-dried sample, the mass density is low as desired, but the burning ratio is the highest under these circumstances, so an optimum range must be found.

The experimental parameters, where the burning ratio does not exceed 10%, and mass density is under 0.2 g/cm^3, are as follows: 14.5 minutes with 64% dry mass content; 14.0 minutes with 68% dry mass content; 13.0 and 12.5 minutes with 72% dry mass content. It is apparent, that the appropriate minutes of treatment and pre-dried sample dry mass content needed to produce quality products are inversely proportional to each other.

The intensity of irradiated energy (double magnetron-treatment ratio) had no significant effect on either the mass density or the burning ratio within the examined range (0.5-1).

5. SUMMARY

Our goal was to prepare the production technology of a crunchy fruit snack by examining the microwave vacuum drying technology on apple raw material. The burning ratio and the product mass density – the two most important quality parameters - were studied depending on the initial dry matter content of the pre-dried product, the specific energy input and its intensity. The initial dry matter content of the pre-dried product and the irradiation time had significant effect on forming a non-burnt and low mass density crunchy dried product. Quality product can be achieved by different inverse combinations of initial dry matter content of the pre-dried product and the irradiation time. (12.5 to 14.5 minutes with 64-72% dry matter content)

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ESTIMATING THE RELATIVE EFFICIENCY OF SEPARATION BETWEEN ENDOSPERM AND BRAN IN THE WHEAT FLOUR MILLING PROCESS

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ABSTRACT

The aim of the wheat flour milling process, along with the size reduction, is to obtain the best possible dissociation of the starchy endosperm from the other parts of the kernel. Milling tends to concentrate various section of the kernel into different flour mill streams but the complete separation of the anatomic parts can not be achieved. The gradinets of ash, protein and cellulose content increase while the starch content decreases from the center portion to the outer portion of the kernel. Considering the significant differencies between the chemical composition of the kernel layers, distribution of chemical compounds in intermediate, final and subproducts of the milling process come as a result of the level of dissociation achieved during the milling process. These differences serve as a basis for the mill process control. Ash determination is probably the most widely used tool while even greater differencies exist in cellulose and especialy stach content. In this work mathematical model has been defined and used to evaluate the relative efficiency of the separation of endosperm from the outer pericarp leyers of the kernel. The model is based on quantity rates (flour extraction and subproducts yield) and qulitative analyses (starch and cellulose content in the wheat, flour and subproducts).

1. INTRODUCTION

Wheat flour milling is a complex process because, along with the size reduction, efficient removal of the bran and germ from the endosperm of the wheat kernel had to be achieved (Posner & Hibbs, 2005). This is possible due to differences in the structural and mechanical properties between the anatomic parts of the wheat kernel (these differences are exaggerated by adding water to the wheat prior to milling in process known as conditioning), a gradual reduction process consisting of repeated size reduction (roller milling) and separation (sifting) and appropriate adjustment of the roll parameters (Kent, 1975).

The aim of the milling process is to obtain the best possible dissociation of the starchy endosperm from the other parts of the grain to yield the white flour (Antoine et al, 2004). The separation should ideally occur at the level of the endosperm-aleurone layer interface. Although the aleurone layer is part of endosperm, it is separated as part of the bran during the milling process (Peyron et al., 2002).

However, it is impossible to mill flour completely free of bran contamination. Milling tends to concentrate various section of the kernel into different flour mill streams but the complete separation of the anatomic parts can not be achieved. The objective in efficient milling is to approach this goal as closely as possible (Posner & Hibbs, 2005).

Considering the significant differencies between the chemical composition of the kernel layers, distribution of chemical compounds in intermediate, final and by-products of the milling process come as a result of the level of dissociation achieved during the milling process. These differences serve as a basis for the mill process control.

Ash (mineral matter) is concentrated in the bran (with over half the total in the pericarp, testa and aleurone) (Kent,1975) and therefore ash determination is of great value to the miller because it is a relatively accurate index of the separation of endosperm from pericarp and germ in any particular flour. The most widely used single measurement of milling efficiency from a technical viewpoint is accumulated ash curve. This can be constructed form the flow rate, percentage of ash and moisture level of all the mill's intermediate flour streams. The individual flour streams are arranged according to ash content, with lowest-ash flour first. Starting with the two lowest ash streams, a series of calculations is made to determine ash content from blending two streams. (Posner & Hibbs, 2005).
The mill's intermediate flour streams also differ in protein quantity and quality (Nelson et al. 1977), the quantity and properties of the pentosans (Ciacco & D`Appolonia, 1982), contents of free lipids and their fatty acid composition (Prabhasankar et al., 1999; Prabhasankar et al., 2000a; Prabhasankar et al., 2000b), distribution of enzymes (Rani et al., 2001). Jensen et al. (1982) suggested the method for quantifying pericarp, aleurone, and endosperm in wheat milling fractions by their autofluorescence characteristics. Antoine et al. (2004) used starch, phytates, *p*-coumaric acid and dehydrotrimer of ferulic acid as markers to quantify the proportion of starchy endosperm, aleurone cell content, aleurone walls, intermediate layer and outer pericarp in bran products.
However, in the industrial conditions, dealing with day to day problems associated with commercial production, some of this analysis is still impracticable and expensive. Compared to ash content even greater differencies between the anatomic parts of the wheat kernel exist in cellulose and especialy starch content. The idea was to define the simplified model that is relatively easy applicable in industry.

2. BASIC MODEL FOR ESTIMATING THE EFFICIENCY OF SEPARATION BETWEEN TWO COMPONENTS

Assuming that material represents the mixture of two components (component 1 and 2) the aim of separation process is to obtain the best possible dissociation between them. Separation results in two fractions, fraction 1 mainly consist of component 1 and fraction 2 mainly consist of component 2 (Figure 1.).

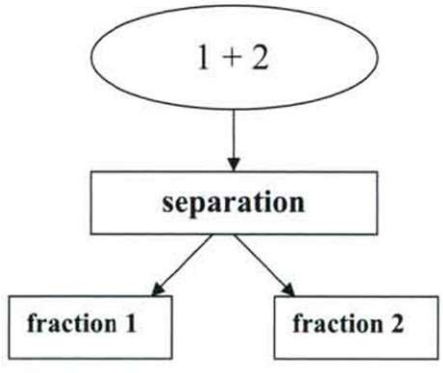

Figure 1. Simplified scheme of the separation process

In ideal situation (complete separation) fraction 1 contains only component 1 (without component 2) while fraction 2 contains only component 2 (without component 1). In reality the complete separation rarely occurs and certain amount of components 2 and 1 are present in fractions 1 and 2 respectively.

The following symbols represent:

Q – mass flow of the native feed
$a_{1/2}$ – content of the components 1 and 2 in native feed
$P_{1/2}$ – mass flow of the fractions 1 and 2
$B_{1/2}$ – yield of fractions 1 and 2 relative to the native feed
φ_{11} – content of the component 1 in fraction 1
φ_{21} – content of the component 2 in fraction 1
φ_{12} – content of the component 1 in fraction 2
φ_{22} – content of the component 2 in fraction 2

having: $a_1 + a_2 = 1$; $B_{1/2} = \frac{P_{1/2}}{Q}$; $B_1 + B_2 = 1$; $\varphi_{11} + \varphi_{21} = 1$; $\varphi_{12} + \varphi_{22} = 1$ (1)

Considering the fraction 1, the efficiency of separation increases with the increase of φ_{11} and decrease of φ_{21} with ideal situation having:

$$\varphi_{11}=1 \text{ and } \varphi_{21} = 0 \quad (2)$$

Considering the fraction 2, the efficiency of separation increases with the increase of φ_{22} and decrease of φ_{12} with ideal situation having:

$$\varphi_{22}=1 \text{ and } \varphi_{12} = 0 \quad (3)$$

The separation efficiency can be defined as a ratio of "achieved level of purity" relative to the "maximum level of purity" (ideal situation). For the fraction 1, achieved level of purity represent difference between φ_{11} and a_1, while for the fraction 2 can be defined as difference between φ_{22} and a_2:

$$\varphi_{11} - a_1; \varphi_{22} - a_2 \quad (4)$$

Maximum level of purity corresponds to ideal situation having:

$$1 - a_1; 1 - a_2 \quad (5)$$

Eqs. (6) and (7) define the separation efficiency considering fractions 1 and 2 respectively:

$$E_1 = \frac{\varphi_{11} - a_1}{1 - a_1} \quad (6)$$

$$E_2 = \frac{\varphi_{22} - a_2}{1 - a_2} \quad (7)$$

The overall separation efficiency also depends on the yield of fractions 1 and 2 (B_1 and B_2) because high level of purity can be achieved but with cost of low fraction yield. Following the increase of the fraction yield, the relative contribution of achieved separation efficiency considering the observed fraction (E_1 or E_2) to overall separation efficiency (E) also increases:

$$E = B_1 E_1 + B_2 E_2; \qquad E = B_1 \frac{\varphi_{11} - a_1}{1 - a_1} + B_2 \frac{\varphi_{22} - a_2}{1 - a_2} \quad (8)$$

Separation efficiency reaches its maximum with $E = 1$ (following $E_1 = 1$ and $E_2 = 1$) which corresponds to the ideal situation.

3. ESTIMATING THE RELATIVE EFFICIENCY OF SEPARATION BETWEEN ENDOSPERM AND BRAN

To study the effectiveness of the wheat flour milling process one needs quantity rates (break release, flour yield, particle size distribution of the output) and qualitative analyses (ash, protein, starch content in the flour or size fractions of the output etc) (Farrell & Ward, 1965). Practically, the efficiency of the milling process is influenced both by the yields of the final (B_1) and by-products (B_2) as well as their "purity" or the absence of endosperm in by-products and bran in final products. Most of the approaches use some of the constituents as an indicator of presence of certain grain tissue in flour mill stream. Contrarily this model is based on an absence of certain constituent as an indicator of absence of tissue in the mill stream. Determination of the starch content in the by-products (bran) of the flour milling process serves as a measurement of the loss of endosperm in bran. Determination of flour cellulose content serves as a measurment of bran contamination of the flour.

This is reason why it is necessary first to know starch content (a_1) and cellulose content (a_1^*) in the wheat (native feed). Knowing a_1 and a_1^*, the values of a_2 and a_2^* defined as a content of all other components in the wheat except starch and cellulose respectively, are coming from eq.(1).

The absence of cellulose in flour indicates the high separation efficiency. Presuming ideal dissociation of endosperm and bran, cellulose content in flour is $\varphi_{11}^* = 0$, while the content of all other components in flour (except cellulose) is $\varphi_{21}^* = 1$. Considering flour (fraction 1) separation efficiency can be defined as:

$$E_1 = \frac{\varphi_{21}^* - a_2^*}{1 - a_2^*} \tag{9}$$

Complete separation of the anatomic parts of the wheat kernel also means that there are no endosperm particles in by-products (bran) with starch content $\varphi_{12} = 0$ while the content of all other components (except starch) is $\varphi_{22} = 1$. Considering bran (fraction 2) separation efficiency can be defined as:

$$E_2 = \frac{\varphi_{22} - a_a}{1 - a_2} \tag{10}$$

Having B_1 and B_2 as the yields of the final (flour) and by-products (bran) of the wheat milling process the overall separation efficiency (E) can be defined as:

$$E = B_1 \frac{\varphi_{21}^* - a_2^*}{1 - a_2^*} + B_2 \frac{\varphi_{22} - a_a}{1 - a_2} \tag{11}$$

Separation efficiency reaches its maximum with E = 1 (following $E_1 = 1$ and $E_2 = 1$) which coresponds to ideal situation that is complete separation between endosperm and bran.

Example:

Starch content in the wheat $-65(\%) \Rightarrow a_1 = 0.65 \Rightarrow a_2 = 0.35$

Cellulose content in the wheat $-3(\%) \Rightarrow a_1^* = 0.03 \Rightarrow a_2^* = 0.97$

Cellulose content in the flour $(\%) - 0.3(\%) \Rightarrow \varphi_{11}^* = 0{,}003 \Rightarrow \varphi_{21}^* = 0.997$

Starch content in the by – products $-25(\%) \Rightarrow \varphi_{12} = 0.25 \Rightarrow \varphi_{22} = 0.75$

Flour yield $-75(\%) \Rightarrow B_1 = 0.75$

By – products yield $-25(\%) \Rightarrow B_2 = 0.25$

$$E = 0.75\frac{0.997 - 0.97}{1 - 0.97} + 0.25\frac{0.75 - 0.35}{1 - 0.35} = 0.82$$

4. CONCLUSION

The model is relatively easy applicable in milling industry. It is based on the data such as flour and bran yield that are practically determined on a daily bases. Also, today lot of the mills uses NIR technology for real-time, on-line control of the milling process. It can be attached to any spout in the mill for evaluation of the flowing material or flour qualitative characteristics that can influence milling performance. Using NIR it is relatively easy to monitor data such as starch and cellulose content of wheat and end-products. This model offers rapid relative measurement sensitive to changes in the mill in order to make a processing response to these changes.

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THE ECONOMIC AND POLITICAL CONSEQUENCES OF THE ACTIVITY OF THE BAJNAI-GOVERNMENT

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ABSTRACT

The international financial and real economy crisis reached Hungary in the autumn of 2008. The crisis made the completion of the state budget and the convergence for the year 2009 very difficult and the continuation of the program according to the plan because the economic recession spoilt the budget
After Gyurcsany Ferenc's resignation, on 16 April, 2009, the new government was established led by Bajnai Gordon. The main task of the Bajnai-government was to carry out the 20 billion Euros credit conditions receiving it from the IMF and the EU, so despite of the 6-7% economical reduction of the year 2009, which meant that the GDP-proportional budget deficit should stay under 4% in the years of 2009 and 2010, too.
The Bajnai-government reduced the budget expenditures with 400 billion HUF in 2009, and in 2010 reduced with 900 billion HUF, and started to rationalize the tax system.

1. INTRODUCTION

Up to autumn 2008 there had been a hope that the deficit in budget of our country in GDP could go under the „magical" 3%, defined by the convergence criterions of Maastricht, by the end of the year. However, the economic crisis coming from the USA reached the countries of the European Union, among them Hungary, too, in the autumn, 2008. As a result, a situation close to the state bankruptcy evolved from the fact that the international – and partly the national- moneylender's capital left the country, which was then avoided with the credit line of 20 billion EUR granted by the International Monetary Fund (IMF), the European Union and the World Bank Group. But neither this credit line was able to prevent the significant decrease in the exchange rate of HUF and the escape of both international and national private capital from the Hungarian economy. International and national indexes of the real economy for the year 2009 showed a less advantageous future. The unforeseeable monetary and real economic processes made the completion of the Finances and Budget Plan for the year 2009 even more difficult. It was clear in the middle of January, 2009 that the national real economy would regress with greater measures than what was expected – with 4-5, or even 7%. (The actual decline was 6,9% in 2009!) It was due to the prospective performance of our major economic partner, Germany. That is why in January, 2009 Gyurcsany Ferenc, the Prime Minister proposed to rectify the budget but he did not want to assume the strict requirements of IMF – e.g. annulment of the old-age pension for the 13th month and the salary of state employees for the 13th month – so he resigned. In April, 2009 the parliament elected Bajnai Gordon for Prime Minister on the basis of an agreement between MSZP and SZDSZ.

2. MATERIAL AND METHOD

The objective of this study is to evaluate realization and economic, political impacts of government programme propounded by the new Prime Minister, Bajnai Gordon on 19 April, 2009. This study has the basic presumption, shared by the Bajnai-government and the international economic and financial organizations, too, that our country cannot or just partially can adopt the traditional budget or monetary means of crisis management –e.g. increase of budget expenditure, decrease of the base rate of issuing bank. In 2009, at the time of the economic recession of 6,7%, and in 2010, when a very modest (1%) economic growth can be expected, the GDP-proportional budget deficit should stay under 4% as it is essential to regain the international public confidence as a result of which the interest surcharges of the international credits granted to our country can be reduced and the exchange rate of the HUF can improve. This way the base rate of issuing bank can be permanently reduced, which leads to the reduction of the market real interest rate which is very high now and which increases competitive disadvantage of the national enterprises. Without a strict budget policy, Hungary could not have obtained the instalments of the credit of 20 billion EUR granted by the international financial organizations. These credits have favourable interests even now, in the autumn of 2010, comparing to other credits which can be granted by the international monetary market.
The author of this study presumes that the financial problems generated by the recession of the real economy cannot shake the country's viable enterprises, the banking system, the state budget, the systems of local governments, education, public health and social welfare, since without comprehensive reforms rational measures can be taken which can secure the functioning of these systems in 2010, as well.

3. RESULTS

The programme of the Bajnai-government propounded on 19 April, 2009 reduced the budget expenditure with 400 billion Fts in the second half of the year 2009. In 2010 they planned to reduce it with 900 billion Fts in order to secure the GDP-proportional budget deficit of 3,8 – 3,9 %, according to the agreement concluded with the IMF and the EU, in 2009 and 2010.

Main measures (Bajnai, 2009):

- annulment of the salary of state employees for the 13th month from July, 2009. Though it is true that in the first quarter of 2010 the government paid the part due to the second half of 2009
- annulment of the old-age pension for the 13th month, but in case of the lowest pensions the possibility of pension correction increased, and pension premium was introduced depending on GDP-growth
- the retirement age gradually increases to the age of 65. Its first impact can be experienced from 2014
- sick pay was reduced by 10%, from 2011 child benefit and maternity leave payment will be paid for 2 years, instead of the earlier 3 years
- at the end of April, 2009 the government price support for gas and district heating was cancelled, but the VAT of district heating was reduced to 5%.

- the national supplement of local governments, agrarian financial supports of the EU, and the government support of the companies of public transport and public media were nominally decreased
- from 1 June, 2009 the VAT of 20%, which anyway increased to 20% from 20% in summer of 2006, grew to 25%, with the exception of some products where it was reduced to 18%
- the employer contribution was decreased by 5%: in 2009 to the twice of the minimum wage, from 2010 regarding the full income. It reduced the financial burden of the sphere of enterprises with 400 billion HUF a year (kormanyozz.hu, 2010)
- from 2010 the total gross wage pays a personal tax of 17% to 5 million HUF / person a year. This measure increased the net wage with 5-15% regarding unchanged nominal sum in the pay-scale of 150-350.000 HUF a month.
- the tax burden of cafeterias has increased significantly
- certain measures of property tax regarding the real property were considered against constitution by the Constitutional Court, so the property tax on real properties were not introduced

Measures of the years 2009 and 2010 on taxes and extras operate at break-even, which means that the government counterbalanced the fall in incomes coming from taxes and extras with reduction of expenditure.

In summer of 2010 the unemployment rate approached 12%, the number of registered unemployed reached half a million, despite of the fact that government programmes to maintain and establish workplaces made the survival of more than 100.000 workplaces possible. (https://hirkozpont.magyarorszag.hu/hirek/ksh20100428.html)

4. CONCLUSIONS

It seems today that measures taken by the Bajnai-government were enough in 2009, and will be enough in 2010 to survive the crisis. Overstepping of the budget deficit of 3,8% planned by the end of 2010 is expected to be 25%, which is 1% of the GDP, that stays behind the limit error in this insecure international and national economic situation. What is more, the original deficit-target of 3,8% can be realized by the 200 billion HUF coming from the tax on banks this year and by blocking a sum of 40-60 billion HUF in the budget expenditure!! Fortunately, dark predictions of Bod Peter Akos did not come true according to which this programme would be suitable only to exhaust the credit limit given by the IMF (Bod 2009). The Bajnai-government did not even call the last part of the credit limit (around 5 billion EUR). The state debt is financed from the international money and stock market again.

To establish the permanent development it is necessary to employ more: the efficient reform of systems of budget, public administration, education, public health and social welfare. Bokros Lajos mentions the critical mass of reforms which reinforcing each other increases the efficiency of both economy and society. (Bokros, 2009)

I think the situation is even more complicated since the question is not only how big the critical mass of reforms which flies us to the front rank of development is, but if there is a field the reform of which can be realized with the available professional knowledge, with a relatively small expenditure and with at least the partial support of the political opposition. In

my opinion, this field is the rational reduction of administrative burdens on enterprises and population.

In Hungary the rate of administrative burdens on enterprises approaches 7% of the GDP. It is about twice as much as the average of developed countries, and is higher with 50-60% than the Czech rate, for example. According to the IMF, productivity could grow with 3% and GDP with 7% in the EU, if the administrative burdens on enterprises were decreased. (Nemeth, 2005) Administration takes 2-2,5 as much time here, in Hungary, as in the developed countries. This over-bureaucratic system of authorities is one of the main reasons for corruption. Multinational companies settling down in Hungary require the direct assistance of the government primarily in authorization and other administrative affairs, beside different financial advantages.

The civil sphere, professional organizations and trade unions are especially weak in this field, they do not demand reduction of administrative burdens consistently and in an organized way. In the years before the political transformation – mainly at time when Nemeth Miklos was the Prime Minister- a process of deregulation had been realized. It should be started again and it would be necessary to extend it to the regulation of the authorities which has not been touched so far, too. In case of reduction of the administrative burdens with 40-50% the expenses of enterprises would be decreased with 800-850 billion HUF a year. There would be tremendous time to analyse and plan the economic processes for the authorities too in case of well-considered checking points. The entrepreneurial disposition would improve, the country's skill to attract capital would grow not only in case of multinational companies but towards other, smaller enterprises, as well. On the bases of reformed administrative tasks it would be easier to construct a much more efficient – and in certain elements smaller- system of political-administrative institutions. The Bajnai-government did not effectuate overall structural reforms, - the administrative burdens were reduced in certain fields, but they increased as a whole because of the restrictions

It is very remarkable that the Bajnai-government could decrease the taxes and extras on the wages despite the reduction of more than 900 billion HUF in budget income due to the economic recession of approximately 7% in 2009. Although, it is true that it was communicated with very low efficiency. This rational step improved disposition of entrepreneurs and employees and their economic situation in 2010 despite of the fact that VAT, other taxes and extras were increased and benefits for the 13th month were cancelled. It became possible to depress the base rate of issuing bank under 6%, which was demanded by FIDESZ, from February, 2010 thus opening the way for reduction of HUF-based credit interest rates and for suppression of the very risky domestic currency credits.

It can be considered a significant result that the exchange rate of HUF could grow stable between 270-280 HUF/EUR despite the reduction of the base rate of issuing bank. Even the commercial balance became equilibrate and in spite of the previous expectations around 5 billion EUR were left from the credit limit of 20 billion EUR till the autumn of 2010.

The following facts played a great part in the relative success of the Bajnai –government: the ideas of the Reform Union (Reformszovetseg) were significantly built in the government programme via the Minister of Finance, Oszko Peter (A Reformszovetseg javaslatai 2009) thus having a great deal to manage the crisis. Bajnai Gordon himself, as an independent leftist, stood primarily as a crisis-managing professional and not a party-politician – this way he could reduce the serious political opposition thus making the realization of the programme easier.

It seems that the Bajnai-government almost exhausted the opportunities of the rational tax-rearrangement possible without economic growth and without introduction of new taxes. Probably the bill on property taxation was introduced and passed in the parliament with content purposely against the constitution- because of the protest of the opposite and the population and the parliamentary elections of 2010.

In 2006-2008 the restrictive programme of 1600-1800 billion HUF of the Gyurcsany-government caused more political tension than the one of 1200-1300 billion HUF of the Bajnai-government because this latter one was considered by the opposite and the population as the necessary consequence of the worldwide economic crisis.

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PROPERTY MANAGEMENT OF SOME AGRICULTURAL COMPANIES IN SOUTH GREAT PLAIN REGION

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ABSTRACT

As it is a well-known fact, the capital requirement of agriculture is high. In addition, its suitability for quick change of activity is significantly limited. The share of agriculture in total investment was remarkably smaller than its contribution to gross domestic product, especially in the nineties. According to a study of Central Statistical Office in 2008 the value of the cancelled investments approaches 129 million Euros from which almost 80% is the loss of the three dominantly agricultural regions (South Great Plain, North Great Plain, and South Transdanubia). Due to the cancelled developments the technical level of agricultural property did not improve significantly contributing to the decrease of the economic significance of the sector. Moreover, the usage of outdated machines and equipment reduces the competitiveness of agriculture.

During the investigation 265 questionnaires were filled in mostly by large-scale agricultural companies in South Great Plain and some of them were interviewed as well. The examination of existing capacities and technologies showed that 60% of the firms have a medium-term plan and 70% of them have an investment plan. This is extremely positive, although most of the investments are based on loans and subsidies. This kind of attitude indicates a certain level of ability for taking risk. In most of the cases the examined investment means technology improvement as well, machinery and building investments were carried out characteristically from subsidies. Developing their own breeds and innovation are generally not typical in the sector, but according to our data their proportion has been increasing. It is interesting that there is not any significant difference between small-scale and large-scale enterprises in connection with innovation activity that is smaller firms at least as innovative as bigger ones.

1. INTRODUCTION

Innovation and its spreading in a certain sector or technology mean some advantage in competitiveness. There can be several barriers of changing the activity or introduction of new breeds or technologies. For instance despite of generally good profitability of wheat production it could not be cultivated profitably in worse soil conditions or a barn is suitable for keeping only certain farm animals in it.

Andrew et al (2010) say that after a pause in 2009 that reflected companies' growing concerns about the economy, innovation is once again a top priority for most companies. At the same time the situation analysis of New Hungarian Rural Development Program highlights the fact that due to the lack of capital most of agricultural enterprises are not able to establish the technological background of competitive production by their own source (Hungarian Ministry

of Agriculture and Rural Development, 2007). According to Udovecz and his co-authors' opinion (2009) there are just few enterprises owned by Hungarians which could not expand their activity especially because of lack of capital, application of outmoded technologies and a remarkably low level of innovation. Therefore, besides other important aspects innovation is necessary for gaining the capability of adaptation.

2. MATERIALS AND METHODS

During the investigation 265 questionnaires were filled in mostly by large-scale agricultural companies in South Great Plain and some of them were interviewed as well. The enterprises investigated cultivate 160 thousand hectare in total and have approximately 5700 employees in South Great Plain. The sample is not representative, bigger firms are intentionally overrepresented because principally large-scale companies can do innovation activities. Of course none of the smaller enterprises have been excluded from the survey since their general attitude (how they can accept or refuse innovation) is important very much in respect of agricultural market.

Data processing was made with MS Excel and OpenOffice statistic programmes. During the data processing in general averages and standard deviation have been considered for the whole sample. Later the differences between the answers of different groups have been measured with Welch-test according to the samples established by revenue and enterprise type.

3. DEFINITIONS

According to OECD-Eurostat (2005) the process-innovation is the realization of the new or significantly renewed way of production or transportation. It includes the important changes in technology, equipment or software. It means purchasing of technological advanced machines, equipment, computer hardware and software, land and buildings (including significant repair, modification and development of existing ones), which requires product- or production-innovation. A lot of activities can be considered innovation when they raise effectiveness and competitiveness by their impact of the given firm. The spread of robot technology is possible in labour-intensive enterprises in the far future (nowadays home lawn mover robots can already be bought).

It cannot be counted on the appearance of fruit picking or weeding robots yet. When they will appear they could remake entirely the plant protection technologies, ecological farming and labour intensive and still competitive enterprises consisting of simple work passes. The currently available technologies have already been suitable for on-line continuous observation and regulation of livestock of an animal husbandry farm through web-camera systems. In addition, remote sensing technologies and regulations through the Internet practically could be realized at a low price.

At the same time new or rather the best and effective possible technologies and machines the most expensive requiring professional skills. Under certain enterprise-size neither capital

available nor expertness are able to draw up with developments. Preferably, bigger companies can operate the well mechanized enterprises properly such as pig, poultry or dairy sectors or crop production where cost-efficiency rather does matter. Contrarily, there are more labour-intensive enterprises (bee keeping, fruit, vegetables and spice plants production, or keeping of furred animals), which are suitable for rentable activity in smaller scale as well.

It can be surely stated that firms having small capital will not be able to follow and utilize certain innovations in the long run because some of them are efficient only on larger areas (due to the economy of scale) or need significant investment. Continuous adaptation is needed to achieve technological development.

4. RESULTS

The condition No. 6 has got the highest rate. It means that the half of respondents would definitely, 26% of them likely develop in the case of stable and reliable market conditions. The other non surprising conditions are the financial ones. In the case of decrease of costs, increase of revenue or subsidy possibilities the likelihood of development is significantly higher as well. The difference between the first and the second condition can be clearly detected. Producers would undertake development when technology or breed has already been spread. The technology, which has not been spread is risky, uncertain and has not been proven.

Table 1. The main conditions of innovation at the surveyed companies (%)

Conditions	ND	0	1	2	3	4	5
1. The technology/breed/process already has been spread	11,3	4,2	5,7	5,7	**35,1**	**24,9**	13,2
2. The technology/breed/process hasn't been spread yet	12,8	13,2	15,5	**22,3**	**21,9**	10,2	4,2
3. The technology/breed is demonstrably better than the current one	8,7	1,5	3,4	3	17	**37,4**	**29,1**
4. I can get subsidy for innovation	5,7	1,9	1,5	2,3	15,5	**31,7**	**41,5**
5. I can take out a loan for innovation	9,1	9,1	5,7	8,7	**25,7**	**25,3**	16,6
6. The market is stable and reliable	7,5	1,1	0,4	0,4	14,3	26	**50,2**
7. The market forces upon it	9,4	4,9	2,3	4,9	**27,9**	**30,9**	19,6
8. The legal environment forces upon it	9,1	7,2	3	7,2	**23,4**	**31,3**	18,9
9. I have enough own source for innovation	9,8	2,6	2,3	3,8	21,5	**26,4**	**33,6**
10. I gain new market with the innovation	8,3	1,5	1,1	3,8	13,6	30,9	**40,8**
11. My costs decrease by innovation	5,7	0,8	1,5	2,3	13,6	30,6	**45,7**
12. My revenue increases by innovation	5,3	0,8	1,9	1,9	11,3	27,5	**51,3**

Note: ND = no data, 0 =, rather change of activity 1 = innovation in no way, 2 = likely not, 3 = perhaps, 4 = likely yes, 5 = definitely yes

The third question also refers to effort for safety and not to taking risk. Most of the companies can be characterised by this attitude. They apply follower or early follower business strategy, the innovator or pioneer attitude come out at 4-5%. The fourth, fifth and ninth questions indicate the problems – the lack of capital – which are typical in agriculture and small and medium sized enterprises. Among equity, credit and subsidy the most popular is use of subsidy, of course. According to statistical data the reliable market seems to be prominently the most important condition. That is absolutely not surprising because almost all parameters are unpredictable, farmers look for reliability in general.

The next question group tried to identify the lacks. Statements contain both external and internal characteristics and factors to which scale answers can be given. The answer "0" represents that the given factor does not impede technological development at all, the answer "5" represents that the given factor impedes it most of all.

Table 2. Distribution of the main barriers of technological innovation

Barriers	ND	0	1	2	3	4	5
1. Lack of investors	11,7%	32,1%	9,8%	10,2%	16,6%	7,9%	11,7%
2. Lack of bank credits	9,8%	17,4%	5,3%	17,0%	20,4%	14,0%	16,2%
3. Lack of subsidies	5,7%	4,9%	1,5%	7,5%	18,5%	25,3%	36,6%
4. Lack of market	7,5%	4,2%	1,9%	3,4%	13,2%	26,0%	43,8%
5. Lack of reliable economic environment	6,8%	1,5%	0,4%	3,4%	10,2%	17,7%	60,0%
6. Lack of education and training	9,2%	18,7%	10,4%	18,3%	31,5%	9,2%	2,8%
7. Bureaucratic or regulations barriers	7,9%	5,3%	1,1%	8,3%	19,2%	19,6%	38,5%
8. Weak efficiency	10,7%	10,3%	4,0%	13,1%	34,9%	16,7%	10,3%
9. Lack of profitability	6,0%	2,4%	0,8%	5,2%	24,6%	20,6%	40,5%
10. Uncertain and risky return	6,3%	1,6%	3,2%	4,8%	16,3%	25,8%	42,1%
11. Lack of plans or planning	7,9%	21,0%	12,3%	15,5%	26,6%	9,9%	6,7%
12. Lack of innovation supporting institutions	9,5%	16,3%	11,9%	15,9%	25,4%	12,3%	8,7%
13. Lack of vertical co-operations	7,9%	17,9%	7,9%	13,9%	25,4%	14,7%	12,3%
14. Lack of proper methodology	10,6%	20,4%	9,8%	15,1%	31,3%	8,3%	4,5%
15. Lack of equity	7,9%	3,8%	3,0%	8,7%	15,1%	23,4%	38,1%
16. Lack of expertise	9,4%	26,8%	13,2%	14,7%	14,7%	12,5%	8,7%
17. Effect of competitors	10,2%	14,7%	7,2%	17,4%	29,4%	15,1%	6,0%
18. Lack of skilled labour	9,4%	20,0%	12,5%	18,1%	20,4%	13,6%	6,0%
19. Lack of manual workers	8,7%	25,7%	9,8%	14,7%	17,7%	12,5%	10,9%
20. Legal barriers	10,2%	19,6%	5,7%	12,5%	25,7%	14,0%	12,5%
21. Lack of innovation readiness	8,7%	17,5%	11,5%	15,5%	32,5%	10,3%	4,0%
22. Lack of taking risk	8,7%	16,3%	9,9%	13,5%	32,9%	13,1%	5,6%
23. Lack of good ideas	8,3%	23,0%	13,5%	14,7%	23,0%	10,3%	7,1%

24. Lack of good examples and practices	7,9%	21,4%	11,1%	17,5%	25,0%	8,7%	8,3%
25. Lack of adequate infrastructure	9,1%	14,7%	8,7%	13,9%	24,6%	17,9%	11,1%

Note: ND: no data, 0: the factor does not impede it at all, 5: the factor impedes it most of all
Presently, the first answer is surprising. Only 11% of respondent states that lack of investors is one of the reasons of development defaults. At the same time the answer is not surprising because agricultural companies characteristically do not count on external investors due to their closed proprietary structure. Moreover, the lack of equity is a serious restrictive factor so normal capital movement can be restricted in the agriculture.

Production methodology, professional knowledge and innovation skills as deficiency factors also have got high scores, but those are not the most important ones. Seeing well the factors investigated, those can be classified into two groups:

- externals, namely factors are independent or dependent to a smaller extent from farmers and
- internals, namely factors can be influenced directly by agricultural companies.

5. CONCLUSIONS

Our main experiences can be concluded as follows:

Lack of reliable economic environment (5)
Most of the characteristics of economic environment (taxes and affixes, bureaucracy, black economy, monetary policy, etc.) can be considered as independent variable in the respect of agricultural companies. This means that influence possibilities made by companies are restricted. In this way adaptation determined but at least influenced by other external and internal factors should remain. So in this point of view a more or less stable regulation environment definitely would be desirable, which could increase reliability, provide better conditions for planning, strengthen the confidence in politicians as well as conduce to the improvement of competitiveness.

Lack of market (4)
In general sense competitiveness means those capabilities of companies, which indicate how they can keep step in different markets with their products and services. Today, import products represent more and more amount in production of agricultural commodity hereby increasing the proportion of internal market get into foreigners' ownership. This fact shows the weak adaptability and competitiveness of agricultural enterprises. Entrance into market is essential because profit gaining requires the gratification of consumer's demand.

Lack of equity (15)
The enterprises being in the red eat up their equity in shorter or longer run they are not able to pay their debts. Their property cannot finance the production or getting loan so they must give up their activities. One of the crucial conditions of sustainable and stable operation of enterprises is availability of adequate amount of equity. Equity is an important source of

assets. The yearly rentable operation increases, which allows technological development and long run prosperity on the basis of owners' decision.

Uncertain and risky return (10)
One of the important indices of return analysis of investment is the time of return. This shows in which year the capital invested can return. Consequently, the time of return is one of the very important indicators of economic rationalism and viability. Uncertainty, risks, unreliable economic environment and doubtful profitability outlook warn agricultural companies. They are forced to cut down or postpone their developments, which put back the improvement their technological development, efficiency and competitiveness.

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STUDY OF POLYVINYL ACETATE FILMS TRANSFORMATION BY IR REFLECTANCE SPECTROSCOPY

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ABSTRACT

The transmitance values measured in IR reflection-absorption (RA) spectra can be used to determine the optical constants of dielectric films laid on solid substrates.
To obtain the optical constants of polymers films laid on steel we used dispersion analysis. In this case, the optical constants are obtained from IR spectrum recorded at a single incidence angle. Using dispersion analysis offers the advantage of processing a large volume of data.
Keywords:
Reflection-absorption, optical constants, IR spectra, dispersion analysis

1. INTRODUCTION

The study of reflection spectra of surface films deposited on solid media allow to determine the thickness and optical constants of these: the refractive index **n** and absorption index **k**.
The reflection of radiation on solid surfaces or transmission is expressed by its complex reflection $\tilde{r} = |\tilde{r}|\exp(i\theta)$ and transmission $\tilde{t} = |\tilde{t}|\exp(i\theta)$ coefficients. They depend on the complex refractive index of the film $\tilde{n} = n - ik$ and the angle of incidence φ_0. The reflectance, denoted R, is the ratio of reflected radiation intensity I_r and incident radiation intensity I_0, and is the square of the complex reflection coefficient: $R=r^2=|\tilde{r}|^2$. The transmittance, denoted T, is the ratio of transmitted radiation intensity I_t and incident radiation intensity I_0 and is the square of the complex transmission coefficient $T= t^2=|\tilde{t}|^2$.

To determine the optical constants of polymer films can be used both external specular reflection spectra and internal reflection spectra.
For the specular reflection on thin polymer films (with thicknesses less than 2μm) deposited on metals, as in Figure 1, the reflected radiation contains two components: one reflected by air-film interface (I_r intensity) and one reflected by film-metal interface (I_t intensity), after having twice crossed the polymer film.

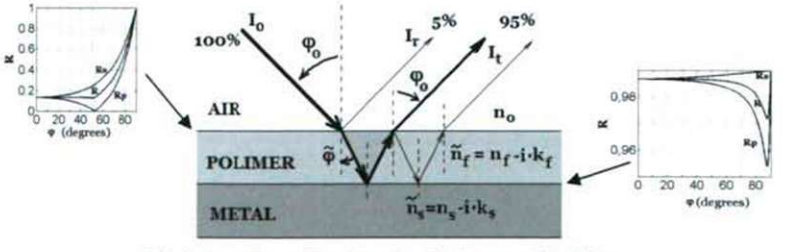

Fig.1 Specular reflection of radiation on thin films deposited on metals

The reflectance due to reflection at the air-film interface has values of about 5% because the values of refractive indices of polymers in the infrared region are less than 1.5. Meanwhile the reflectance at the polymer-metal interface has values over 99%. Thus, the radiation intensity reflected at the polymer-metal interface and twice crossing the polymer film is about 95% of incident radiation intensity, and almost 20 times greater than the beam directly reflected at the air-polymer interface. Therefore, this spectrum is a reflection-absorption (or transflectance) spectrum, and is similar in terms of quality of transmission spectrum of the polymer film. This spectrum can be processed to obtain the optical constants **n** and **k** corresponding to the complex refractive index $\tilde{n} = n - ik$ [7].

The two optical constants can be obtained either from the reflectance measurements at two angles of incidence or using the whole range of reflectance spectrum values at one angle of incidence [5]. In the second case, Kramers-Kronig analysis of the recorded spectrum is used [10,11].

The dispersion analysis is another way to obtain the optical constants of thin films deposited on metal surfaces. It is more flexible than Kramers-Kronig analysis and can be applied to more complicated geometry of the spectrum.

Dispersion analysis is based on building an appropriate model for dielectric function and calculating the optical properties corresponding to this model. The best known is Drude-Lorentz model [6, 9, 12] which defines the electric permittivity:

$$\varepsilon(\nu) = \varepsilon_\infty + \sum_j \frac{\nu_{pj}^2}{\nu_{0j}^2 - \nu^2 - i\gamma_j \nu} \tag{1}$$

It describes the optical response of a set of harmonic (damped) oscillators. In this relation, ε_∞ is so-called "high-frequency dielectric constant", which represents the contribution of all oscillators at very high frequencies (compared to frequency range under consideration). The parameters ν_{pj}, ν_{0j} and γ_j are the "plasma" frequency, the transverse frequency (eigen-frequency), and the line-width (scattering rate), respectively of the j-th Lorentz oscillator. For the proposed model, from permittivity, we can calculate all optical quantities such as reflectance R and transmittance T. The spectrum of these theoretically calculated quantities is compared with those experimentally determined. The model parameters are continuously adjusted to fit the theoretical values with experimentally measured data. In case of reflection-absorption spectra the theoretical transmintance and experimental transmitance spectra are compared. The fitting parameters process stops when the differences between theoretical and experimental spectra are minimal.

Suppose, we have a set of N experimental data points $\{x_i, y_i, \sigma_i\}$ (j = 1, ... N) that we want to fit. Here, x_i is the light frequency, y_i is the data value, and σ_i is the data error bar. For a set of M internal parameters, the values $y = f(x, p_1, ... P_M)$ are calculated based on the model.

The so-called Levenberg-Marquardt algorithm is used to minimize the value:

$$\chi^2 = \sum_j^N \left(\frac{y_j - f(x_j, p_j .... p_M)}{\sigma_j} \right)^2 = \chi^2(p_1, ... p_M) \tag{2}$$

Fitting process stops when the stopping criterion is met [8].

2. EXPERIMENTAL

Thin films of polyvinyl acetate (PVAc) were obtained by spraying a polymer solution on the surface of a steel metal sample. Low concentration of polymer in the solvent allowed us to obtain thin films with thickness less than 2μm. After evaporation of the solvent the IR reflection-absorption spectra at 20^0 incidence angle was recorded. The metal sample coated with polymer film was then heated to a temperature of 80^0 C for 30 minutes to complete removal of the solvent. After the sample heat treatment we recorded IR reflection-absorption spectrum again. The metal surface used as substrate for the polymer film was obtained by grinding and polishing.
The IR reflection-absorption spectra were recorded using a specular reflectance device for UR-20 spectrograph.
The reflection-absorption spectra were processed using the program RefFIT [8] to obtain the optical constants of polymer film.

3. RESULTS AND DISCUSSION

The IR reflection-absorption spectra recorded at 20 degrees incidence angle are shown in Figure 2. The spectral range 500÷ 1800 cm^{-1} containing the absorption band at 1732 cm^{-1} corresponding to C = O stretching vibration is presented [3].
The reflectance R and hence the transmitance T values depend very least on the angle of incidence, as observed in Figure 1. Because of this, reflection-absorption spectrum at 20 degrees angle of incidence is very similar to the transmission spectrum for normal incidence.
Since the surface film thickness is less than 2μm, interference fringes in spectra recorded are not present [6]. For the same reason the spectrum recorded is one of reflection-absorption (transflectance).

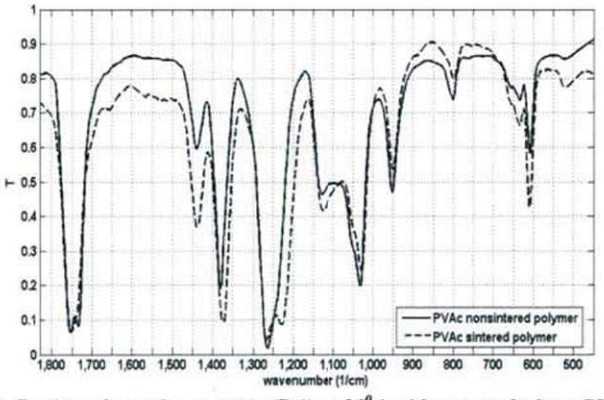

Fig.2 Reflection-absorption spectra (RA) at 20^0 incidence angle for a PVAc film deposited on polished steel

The IR spectra of PVAc film deposited on steel recorded after its heat treatment, shows the appearance of a thermal degradation process of polymer, which is its depolymerization.
The depolymerization process produces monomer units containing unsaturated C = C bonds. This is confirmed by increased of the absorption band at 1647 cm^{-1} characteristic for stretching

frequency of C = C bond [2,3]. During thermal degradation is also possible to remove the acetic acid. This is highlighted by the change of vibration frequencies of C = O, C-O and C-C-O bonds. Thus, instead of stretching vibration frequencies of the C=O bonds at 1724 cm^{-1} and 1737 cm^{-1} there is a single band at 1750 cm^{-1}. Instead of the absorption band at 1241 cm^{-1}, corresponding to vibration frequency of C-O bond appear two absorption bands at 1230 cm^{-1} and 1270 cm^{-1}. They correspond to C-O bonds in the acetate group linked to the macromolecular chain or partially released. Also, there is a decrease in the intensity of the absorption band at 1124 cm^{-1} corresponding to the vibrations of C-C-O bonds [3].
The spectra obtained can be processed to obtain the optical constants **n** (refractive index) and **k** (absorption index).
We used 1381 points and 55 parameters in the fitting process.
To improve the accuracy of the dielectric function we used simultaneously the fitting process of reflection-absorption spectra recorded at a 20 degrees incidence angle and the refractive index of PVAc value $n_f = 1.4665$ [1].
The refractive index spectrum obtained by dispersion analysis of reflection-absorption spectrum for PVAc deposited on steel is shown in Figure 3.

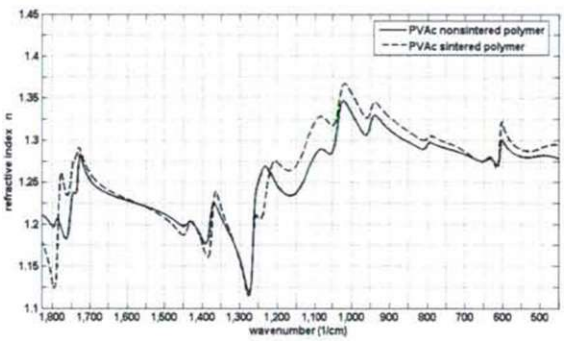

Fig. 3 Refractive index spectra for PVAc deposited on steel obtained by dispersion analysis

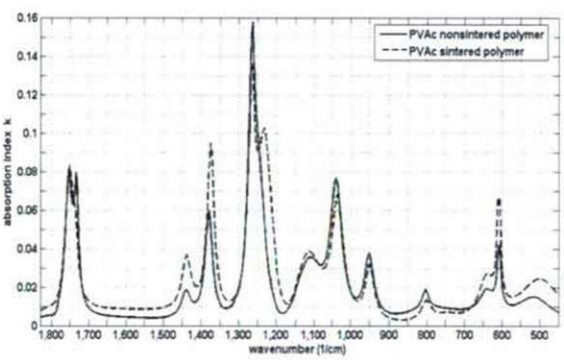

Fig. 4 Absorption index spectra for PVAc deposited on steel obtained by dispersion analysis

The absorption index (extinction coefficient) **k** has a spectrum very similar to the absorption spectrum. The absorption coefficient spectrum of PVAc film deposited on steel is shown in Figure 4. The values of the absorption coefficient are low. The polymer can be considered to

be almost transparent in infrared. In this spectrum, the absorption bands do not show deviations from the positions of the absorption bands in reflection-absorption spectrum.

4. CONCLUSIONS

The IR reflectance spectra for thin films (with thickness less than 2μm) are reflection-absorption spectra. The recorded size is the transmitance. Appearance of the reflection-absorption spectra is very similar in terms of quality to the transmission spectrum of the polymer.
The dispersion analysis of reflection-absorption spectra is more accurate and easier than Kramers-Kronig analysis. The Kramers-Kronig analysis is used especially for thick surface films or for bulk materials.
Simultaneously fitting for several types of information about the film surface leads to accurate values of optical constants **n** and **k**.

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INFLUENCE OF STATIC MIXER ON THE CROSS-FLOW MICROFILTRATION OF YEAST SUSPENSIONS

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ABSTRACT

This work studies the influence of operating factors on the microfiltration of baker's yeast (Saccharomyces cerevisiae) in presence of static mixer as turbulence promoter. Microfiltration is typically used to remove particles in range 0.1–10 μm from a suspension. It is a pressure-driven process widely used in concentrating, purifying or separating suspended particles and macromolecules from solution. During cross-flow microfiltration process permeate flux decreases with time as the retained particles are accumulated on and within membrane surface area where they create additional resistance to permeate flow. External fouling of the membrane is the result of cell, cell fragments and rejected particles accumulation on the top of the membrane surface in the course of cake formation, while deposition of the macromolecules and small particles inside of the internal porous membrane structure results in internal fouling, which is often irreversible contrary to usually reversible external fouling.
Experimental work was done with three membranes (A, B and C) with pore size 200, 450 and 800 nm. The results of microfiltration experiments for each membrane were estimated by analyzing the permeate flux without static mixer; permeate flux with static mixer; permeate flux improvement; reduction of specific energy consumption. Experimental results suggest that even though membrane A has smallest pore size of 200 nm it has the best performance considering steady state flux and reduction of specific energy consumption.

1. INTRODUCTION

Microfiltration is typically used to remove particles in range 0.1 to 10 μm from a suspension. It is a pressure-driven process widely used in concentrating, purifying or separating suspended particles and macromolecules from solution. During cross-flow microfiltration process permeate flux decreases with time as the retained particles are accumulated on and within membrane surface area where they create additional resistance to permeate flow. External fouling of the membrane is the result of cell, cell fragments and rejected particles accumulation on the top of the membrane surface in the course of cake formation, while deposition of the macromolecules and small particles inside of the internal porous membrane structure results in internal fouling, which is often irreversible contrary to usually reversible external fouling.
Avoidance of membrane fouling is not possible but it can be limited by the applying a number of different techniques. In addition to increasing filtration rate avoidance of membrane fouling makes it easer to clean them. Some of these techniques include backflushing [1, 2, 3], gas sparging [4, 5], turbulence promoters or static mixers [6, 7] and many others. The use of turbulence promoters or inserts in the tubular membrane is one of the technique applying hydrodynamic methods in reducing permeate flux decrease i.e. controlling membrane fouling. Turbulence promoters or inserts have many shapes and sizes. There are static rods, Kenics static mixers, metal grills, spiral wire, cone shape inserts, disc and doughnut shape inserts. A number of studies has been conducted in order to investigate influence of turbulence

promoters on the permeate flux increase during filtration process. Krstic et al. [6, 8] investigated influence of Kenics static mixer on the skim milk microfiltration, and their results suggest significant permeate flux increase when static mixer were inserted in the membrane channel. This type of mixers was successfully applied for permeate flux enhancement during separation of non-sucrose compounds from sugar-beet syrup by ultrafiltration with ceramic membrane [9]. Gupta et al. [10] conducted a study of the employment of helical baffles in membrane filtration of baker's yeast and dodecane-water emulsion was through ceramic membrane. Helical baffles with a different number of turns per baffle length. The authors reported that under the operating conditions, the use of a helically wound baffle in a membrane managed to increase the permeate flux at the same hydraulic dissipated power and without any additional equipment such as pulsating pump or any backwashing system. In cross-flow microfiltration with tubular ceramic membranes, turbulence promoters are inserted into membrane channel where they generate turbulence which subsequently reduces membrane fouling by producing a helical flow pattern and generating secondary flow to hinder the formation of a particle layer above the membrane surface. Helical baffles are likely to perform better compared to rod inserts, implying that the helical vortices improve the mixing between the boundary layer on the surface of the membrane and the bulk fluid to a greater degree than by simply generating turbulent flow using cylindrical rod inserts [7].

2. MATERIALS AND EXPERIMENTS

Baker's yeast (Saccharomyces cerevisiae) was used to make the yeast suspensions for the experiments. These microorganisms were selected according to their well-defined granulometric properties and their potentials to chemically clean the membrane. Prior to each experiment suspensions were prepared by adding a given weight of commercially available dry baker's yeast (Alltech-Fermin, Senta, Serbia) in saline solution (8.5 gL^{-1} sodium chloride) and stirred for 25 minutes. The sodium chloride balance the osmotic pressure across the cell wall, which if omitted would result in cell rupture.

The experiments were carried out in a conventional cross-flow microfiltration unit (Figure 1.). The feed was circulated by a peristaltic pump (ISMATEC, Switzerland). During experiments, both permeate and retentate were recycled back to the suspension reservoir. The transmembrane pressure difference was adjusted by the regulation valve. The inlet and outlet pressures of the membrane module were measured by two pressure gauges. The average of these two pressure values gave the value of transmembrane pressure as the outside of the membrane is vented to the atmosphere. The membrane module used was a Membralox^{TM} 1T1-70 module (SCT, Bazet, France). The single channel ceramic membrane used had a nominal pore size 200, 450 and 800 nm (TAMI Deutschland) with the length of 250 mm and inner/external diameter of 6/10 mm. The useful membrane surface was 4.33×10^{-3} m^2.

The permeate flux was calculated from the time needed to collect 10mL of permeate. All measurements in this study were carried out in triplicate and the results averaged. The reproducibility of these measurements were good, the deviation between parallel experiments were in the range of ±6%. All experiments were carried out at the room temperature (25 °C). Experimental work was done with three membranes (A, B and C) with pore size 200, 450 and 800 nm.

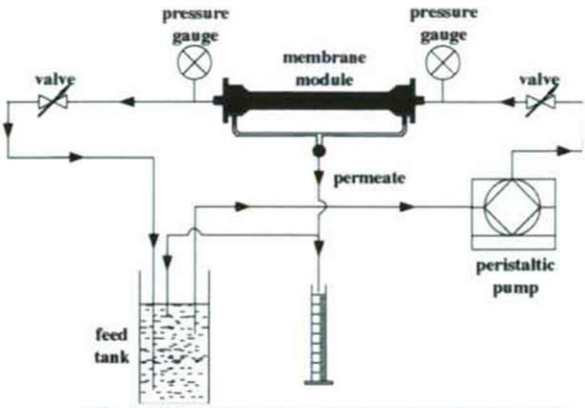

Fig. 1. Conventional cross-flow microfiltration unit

The static turbulence promoter used throughout experiments was the stainless steel Kenics static mixer. The static turbulence promoter was inserted inside the whole membrane tube and was fixed appropriately to avoid any movement due to the fluid flow. The Kenics static mixer used throughout experiments had 30 mixing elements with the diameter of 5 mm. It consists of a series of helical mixing elements made from thin, flat strips, twisted through 180° to form helices. Helices are turned around their main axis by 90° against the next element. Its characteristic geometric design produces the unique patterns of flow division and radial mixing simultaneously. Furthermore, the Kenics static mixer has "streamlined" shape which presents minimal surface area in the plane normal to the tube axis and prevents the creation of stagnation regions where impurities may collect and eventually foul the membrane. These features strongly favored the Kenics static mixer in respect to other commercial static mixers for cross-flow filtration applications [6].

2.1. Calculations

The efficiency of the static mixer as a turbulence promoter was determined as the improvement of permeation flux defined as [6]:

$$FI = \frac{J_{P,SM} - J_{P,NSM}}{J_{P,NSM}} \times 100$$

where FI, improvement of permeation flux (%); $J_{p,\,NSM}$, permeate flux without static mixer (L/m^{2}h); $J_{p,SM}$, permeate flux with static mixer (L/m^{2}h).
The efficiency of the static mixer as a turbulence promoter was also determined by reduction of specific energy consumption (ER). One of the most important parameter from an economical point of view is the specific energy consumption (E) defined as the power dissipated per unit volume of permeate [6]. The hydraulic dissipated power can be expressed as a product of feed flow rate and pressure drop along the module:

$$P = Q \cdot \Delta P$$

where P is the hydraulic dissipated power (W); Q feed flow rate (m^3/s); ΔP pressure drop (Pa). The specific energy consumption can be calculated as:

$$E = \frac{P}{J_P A}$$

where E specific energy consumption (kWh/m^3); J_P, the permeate flux (L/m^2h); A membrane surface (m^2). Reduction of specific energy consumption is defined as:

$$ER = \frac{E_{NSM} - E_{SM}}{E_{NSM}} \times 100$$

where ER, reduction of specific energy consumption (%); E_{NSM}, specific energy consumption without static mixer (kWh/m^3); E_{SM}, specific energy consumption with static mixer (kWh/m^3).

3. RESULTS AND DISCUSSION

3.1. Permeate flux without turbulence promoter

The first set of experiments was carried out to determine influence of membrane pore size on the permeate flux without turbulence promoter. The operating parameters were suspension concentration 6 g/L, transmembrane pressure 1 bar (10^5 Pa) and feed flow rate 130 L/h. Results of these experiments are shown in Figure 2.

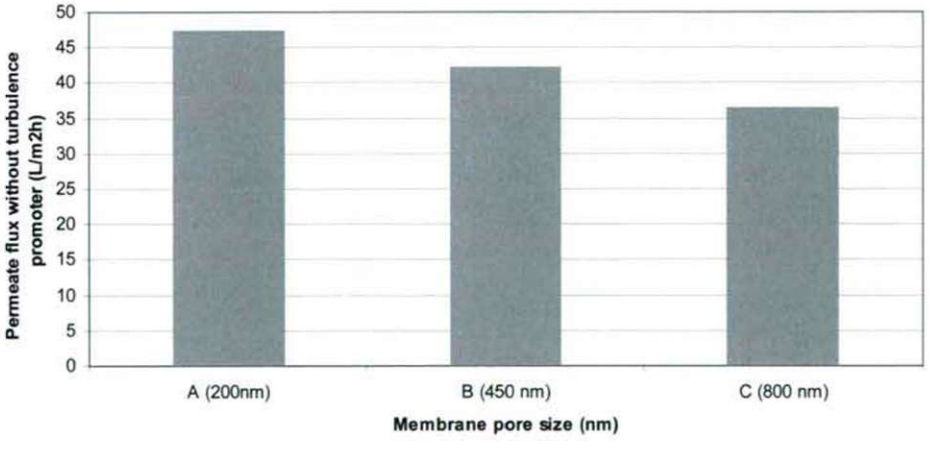

Fig. 2. Values of steady state permeate flux without turbulence promoter for different membrane pore sizes

As it can be seen permeate flux without turbulence promoter has the highest values for the membrane with the smallest pore size, in this case 200 nm. This behavior can be explained by fouling mechanism. One of the main characteristics important for microfiltration process is composition of filtration medium i.e. suspension. Components of suspension can influence microfiltration process directly or indirectly. Direct influence is fouling of membrane surface [11, 12], while indirect influence is manifested through modification of cell surface that can lead to changes in cell absorption to membrane surface [13].
During the experimentation process suspensions were made by adding predetermined quantity of dry baker yeast to the physiological solution. Suspension prepared in this manner, in addition to yeast cells have diluted cell material from the broken cells. This cell material consists from different types of sugars, proteins and etc. Particle size of this kind of materials is lesser when compared to the size of yeast cells. So, when these so called unwashed suspensions are filtered internal fouling can occur that can lead to the further steady state permeate flux decline. Internal fouling is particularly manifested when membranes with bigger pore size are used. Stopka et al. [14] reported that during microfiltration of beer similar results that permeate flux is smaller for membranes with pore size of 500 nm compared to flux when membrane with 200 nm pore size was used.

3.2. Permeate flux with turbulence promoter

The second set of experiments was carried out to determine influence of membrane pore size on the permeate flux with turbulence promoter. The operating parameters were the same as for experiments without static mixer (suspension concentration 6 g/L, transmembrane pressure 1 bar (10^5 Pa) and feed flow rate 130 L/h). Results of these experiments are shown in Figure 3.
By inserting turbulence promoter into membrane channel flow patterns inside channel are changed. Static mixers, in this study Kenics static mixer, characteristic geometric design produces the unique patterns of flow division and radial mixing simultaneously as well as its "streamlined" shape which presents minimal surface area in the plane normal to the tube axis and prevents the creation of stagnation regions where impurities may collect and eventually foul the membrane. This changes lead to decrease in cake formation i.e. the cake buildup at the membrane surface is hindered and in this is the reason for increase in permeate flux increase compared to the process without turbulence promoter. The positive effects of turbulence promoter are recorded for all three membranes used but the highest flux values were obtained for membrane with pore size 200 nm (membrane A).

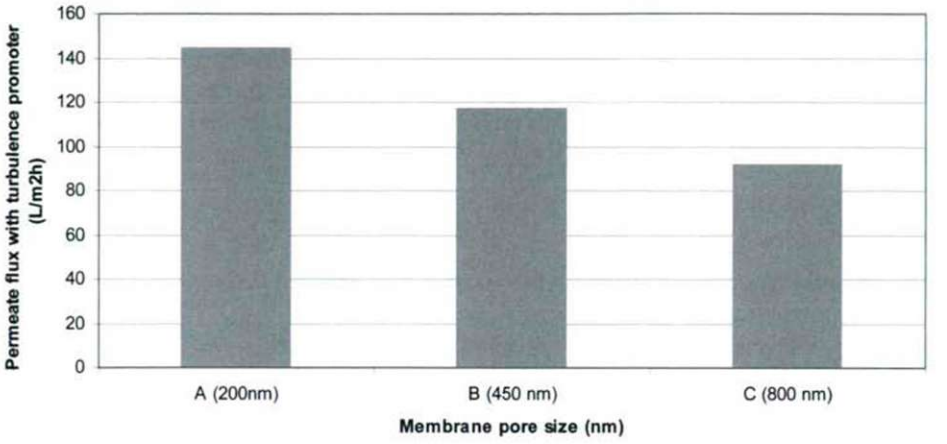

Fig. 3. Values of steady state permeate flux with turbulence promoter for different membrane pore sizes

3.3. Improvement of permeation flux

Improvement of permeation flux was calculated according to the given equation and the results are shown in Figure 3. As it was said earlier inserting the Kenics static mixer into membrane channel lead to the increase of permeate flux values for all selected membranes and this positive effect can be attributed to the increase in feed velocity, which resulted in less cake buildup and consequent less flux reduction.

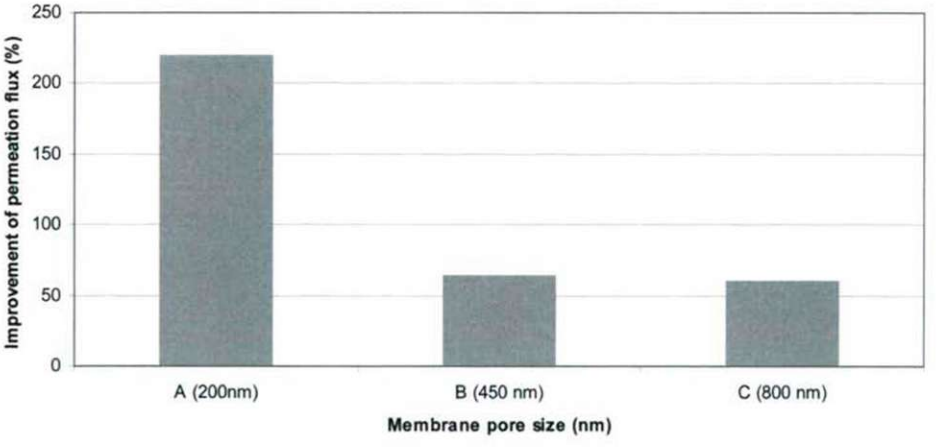

Fig. 3. Values of improvement of permeation flux for different membrane pore sizes

The results suggest that the biggest improvement of permeation flux was achieved for the membrane with the smallest pore size i.e. 200 nm. As it was said earlier during cross-flow microfiltration processes permeate flux decreases with time as the retained particles are accumulated on and within membrane surface area where they create additional resistance to permeate flow. External fouling of the membrane is the result of rejected particles

accumulation on the top of the membrane surface in the course of cake formation, while deposition of the macromolecules and small particles inside of the internal porous membrane structure results in internal fouling. By inserting static mixer inside ceramic membrane flow patterns are changed and in this way external fouling is reduced. On the other side internal fouling is less influenced by static mixer [6, 8]. So the flux improvement is much more prominent for the membranes with smaller pore size as for them internal fouling is less manifested.

3.4. Reduction of specific energy consumption

Specific energy consumption is function of pressure drop along module and permeates flux achieved for specific experimental conditions and membrane surface area. By inserting turbulence promoter into membrane channel both of these variables are changed. Pressure drop along membrane is higher because of the increased resistance to feed flow, but on the other side permeate flux is increased due to the changes in fluid flow through membrane. In order to justify the use of static mixer from economical point of view reduction of specific energy consumption must be high as it is possible. That is achievable only in cases when increase in permeate flux is high enough to compensate for increase in energy usage needed for feed flow with turbulence promoter, i.e. increase in pressure drop along membrane channel. This is the reason why information about improvement of permeation flux can be to some extent ambiguous, since flux is always higher when turbulence promoter is used.
Reduction of specific energy consumption was calculated according to the given equation and the results are shown in Figure 4. It represents one of the most important parameter from an economical point of view. As it can be seen from Figure 4. the reduction of specific energy consumption has highest values for membrane A (200 nm). Similar results were reported for the microfiltration of skim milk [14].

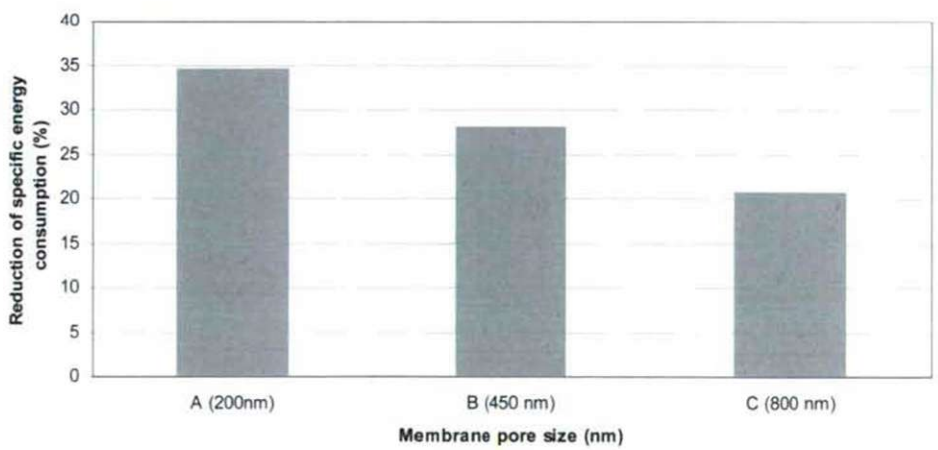

Fig. 4. Values of reduction of specific energy consumption for different membrane pore sizes

4. CONCLUSION

The results of this study illustrate the importance of proper membrane selection for microfiltration processes. The application of Kenics static mixer has positive effects on microfiltration of baker's yeast (Saccharomyces cerevisiae), i.e. permeate flux increases when static mixer is inserted into membrane channel. When the turbulence promoter is inserted fluid flow pattern are changed. This increased scouring of the membrane surface lead to decrease in cake layer thickness resulting in increased flux values. Experimental results suggest that even though membrane A has smallest pore size of 200 nm it has the best performance considering steady state flux value as well as reduction of specific energy consumption.

Acknowledgement
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STUDIES AND RESEARCHES CONCERNING THE DETERMINATION OF THERMAL TREATMENT OF THE ADAMIT TYPE HYPEREUTECTOIDE STEEL, ON CAST SAMPLES

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ABSTRACT

In this paper are presented lab experiments done on the purpose of determination of the thermal treatment technology (with the purpose of obtaining some corresponding hardness and their use in the production practice) and mechanical characteristics of the hypereutectoid steel, Adamite type, intended for casting the mill rolls. Samples have been taken out of three charges, out of which four rolls have been cast at metallurgical company. The test assays to determine the characteristics of the material have been done at the Engineering Faculty of Hunedoara.
Diagrams of thermal treatment applied to the mill rolls of Adamit type steel and cast sampled are presented, as well as the hardness values registered. The application of thermal treatments in the case of the mill rolls cast of hypereutectoid steel has a multiple character, respectively:

- eliminate the internal tensions which have very high values;
- decrease the hardness obtained at casting (370…400HB), till the values between the interval 280…300 HB, in view to increase the processing by splinting;
- correct the primary structure by destroying the cementite network, increase of the pearlite grains and its fineness in order to assure the imposed mechanical properties and especially the growth of the rolls face (not only in the superficial stratum but also in depth) at values of 380…420 HB.

Key words: mill rolls, thermal treatment, hypereutectoid steel, Adamit

1. INTRODUCTION

The Adamite type steels, called in the speciality literature "wild cast irons", have 1,8…2,2% carbon and they are alloyed with Cr, Ni, Mo. As material, the Adamite type steel is situated, from the point of view of the chemical composition in the field of hypereutectoide steels alloyed with Cr, Ni, Mo, so that we have to apply on it operations of heat treatment. With the emergence of the punctiformal graphite as an effect of the heat treatment of annealing, structurally it has angle of crossing with the cast irons, too [1, 2, 3, 4].
Thus, in order to obtain the characteristics of the hardness and the wanted microstructure, to the mill rolls of Adamit Type steel are applied two thermal treatments, primary and secondary, whose diagrams are presented in fig. 1 [5, 6].

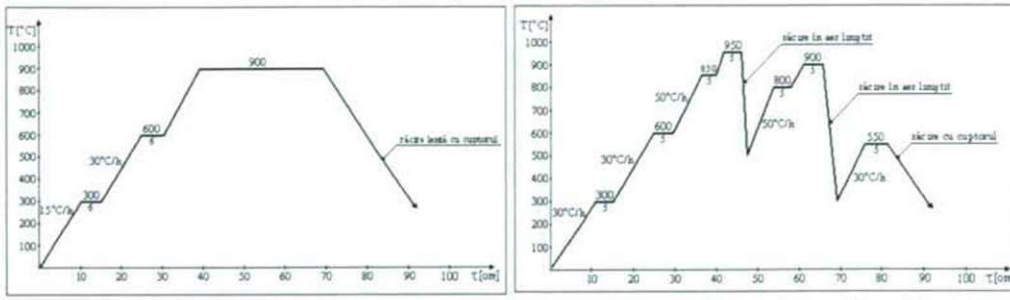


Figure 1. The thermal treatment applied to the mill rolls of Adamit type steel: a - primary thermal treatment; b - secondary thermal treatment

After the analyses done in the industrial practice we establish the following [5, 8]:

- in raw casting state, the mill rolls Adamit type have a high hardness (392...399HB) and therefore, they are subdued to a preliminary thermal treatment of softening, after which the hardness is decreased to 260...285 HB, so that they can be subdued to the mechanic chip removing process;
- After the mechanic process, the rolls are applied a secondary thermal treatment (steeling), after which the hardness increases at values at 380...440 HB on table's' face and 290...310 HB on necks, hardness that assure a good behavior in exploitation.

2. EXPERIMENTAL RESULTS

One very important aspect connected to the behaviour in exploitation of the mill rolls is the knowledge of the materials characteristics of which they are made. A very important problem connected to the mill rolls cast of hipereutectoid steel Adamit Type (OTA3) is that of establishing a corresponding thermal treatment which provides the possibility of processing, as well as the obtaining of some final hardness at high values, able to carry out a good wear strength [6].

In order to determine the mechanical characteristics of the steel the rolls are cast, respectively OT-A3, samples were taken at casting, in cylindrical form (fig.2, b), with the next dimensions: diameter d = 60mm and length L = 300mm. The samples were cast in moulds (fig.2, a) painted in heat resisting finish, in order to control the change of the heat charge towards outside, the difference between the rolls and the cast samples being too big. The samples have been taken from three charges, out of which four condensing roll sets have been cast, with different dimensions [7, 8].

a. b.

Figure 2. The moulds and the cast samples to determine the mechanical characteristics

The hardness of the cast samples was determined with the help of Rockwell Durometer, existing in the Heat Treatment Laboratory at the Faculty of Engineering Hundoara. The hardness was determined in scroll, on three generators, situated at 120 degrees between them [7, 8]. The 12 samples, cast in three different charges, are going to be constrained to heat treatments. Taking into account the fact that the diagrams of heat treatment applied to the rolls cast of hypereutectoide steel, Adamite type [5, 6, 7], and diagrams of heat treatment for cast samples, respectively assay-samples obtained out of them were laid down (fig. 3).

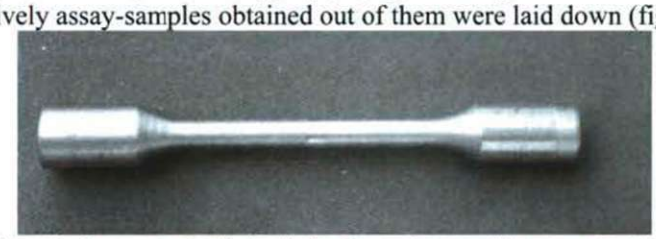
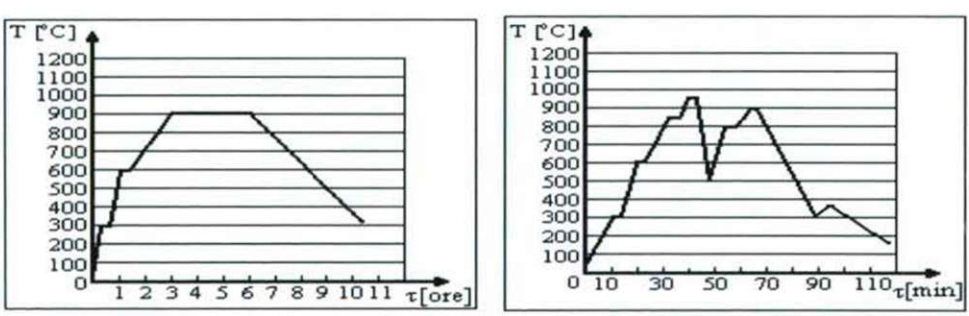


Figure 3. Assay-sample obtained of roll sample, cast of hypereutectoid steel

After manufacturing, the assay-samples were constrained to the secondary heat treatment, which has as purpose the increasing of hardness. The two heat treatments applied to the cast samples, respectively assay-samples obtained out of them, and were executed at the Engineering Faculty of Hunedoara (fig. 4) [5].



a. b.

Figure 4. The thermal treatment applied to the cast sampled of the Adamit type steel: a-primary thermal treatment; b-secondary thermal treatment

3. CONCLUSIONS

In account with the fact that the rolls cast of Adamite type steel, with a high content of carbon and alloyed with Cr,Ni,Mo, used at S.C. Arcelor Mittal S.A. Hunedoara, have won a large dispersion at the medium and small section mill, as well as at the wire mill the determination, on samples, of the mechanical characteristics of this type of alloyed being useful.
For the prominence of the differences recorded for recorded hardness at casting, after the primary heat treatment and after the secondary heat treatment, the bar chart from fig.5 was laid out, which systematise the recorded results, for all the three stages of hardness determination.

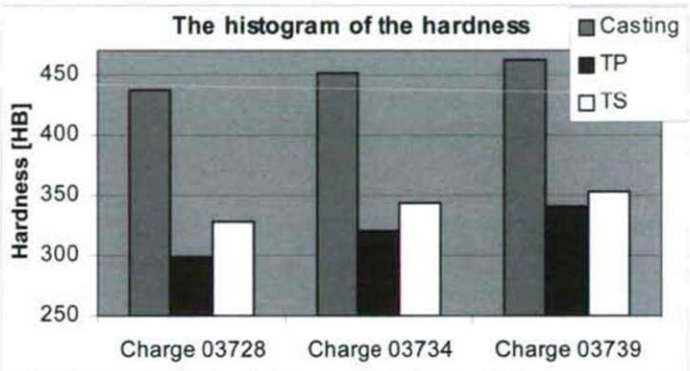


Figure 5. Comparison of hardness recorded (at casting, after primary and secondary heat treatment) in charges case 03728, 03734, 03739

After the performance of the experiments on the three charges it results that [5]:

- the hardness of the cast samples, before the primary heat treatment are situated in the interval 434,2…463,8 HB;
- the medium recorded hardness, after the primary heat treatment, are situated in the interval 298,264…341,247 HB;
- after the processing of the assay-samples and the secondary heat treatment the final hardness were situated in the interval 328,28…353,23 HB;
- the values hardness are situated in the limits provided by the standards in stoutness;

To conclude, we can establish that the hardness obtained at casting, respectively after thermal treatment applied, it is very important because of the fact that it plays a main role in the throttling process, with direct influences on the exploitation hardness.

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FLASH FLOOD WARNING SYSTEM FOR SMALL RURAL COMMUNITIES

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ABSTRACT

This paper presents some aspects concerning early wireless flood alarm systems for small rural communities.
Due to recent heavy rain period and great amount of water per square meter over a short period of time, one must pay attention to several devices able to prevent the loss of life's and material damages produced by local rapid and intense floods.
One solution of a flood alarm system can be a device containing a flow rate transducer, power source and wireless module including directional antenna.
The proposed alarm device can be placed on the rivers at considerable distance from the populated area; the flood alarm signal is transmitted in real time by the directional antenna to the intervention center so they can assure the adequate protection for the peoples and major objectives.

1. INTRODUCTION

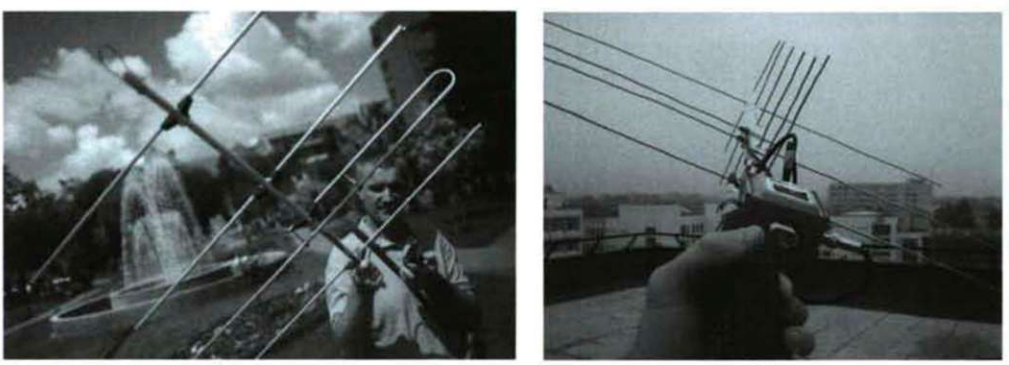
Floods are natural threading phenomena that can produce loss of human lifes, material damages and economical draw-back effects on a large scale. "A sudden local flood of great volume and short duration" can bee a definition provided to flashfloods. The causes can be heavy rain or melting snow in conjunction with rain, dam failure can also produce important flash flood.
Rapid flash flood development causes the los of human life's and important material damages.
Among the category of floods the sudden flood or the so called flash flood can develop without warning and develop very rapidly with high velocity and important displacement forces. Those characteristics make from flash floods an important risk factor for the inhabited areas.
Small communities located outside the general warning system guarding the important water streams are exposed to flash floods especially when the community is at the base of a mountain area or a large reservoir.
This paper proposes a possible solution for small communities exposed to the flash flood impact. The base idea is to achieve an early warning of the authorities, both acoustical and by wireless message.

2. STRUCTURE OF THE PROPOSED WARNING SYSTEM

It is important that small endangered communities are provided with early warning systems, the warning can be acoustic or by data transmission (wireless or by cable).
The means to produce early warning can consist of :

- power source
- communication module
- level, flow rate transducers

The power source must supplies about 1.5 A in emission and about 0.15 A in stand-by and 7.2 to 12 V. A Li-ion or Ni-Mh battery pack can fulfill the task and can be reloaded using wind generators or solar cells. Also local electrical network can provide the necessary functioning parameters.
The communication module must achieve point to point contact from the measurement site to the local authorities, the estimated distance to be covered is 10 km, and the maximal emission power is 5 W with a directional antenna like the Yagi-Uda or the log-periodic antenna.
The antenna can be Yagi-Uda or log-periodic type, for the communication tests one four elements VHF Yagi antenna and a 3 elements VHF combined with 6 elements UHF antenna was used, the antenna has a max. 1.5 m boom length and it is about 1 m wide (see Figure. 1).



a) b)

Fig 1. Experimental antenna types

a) 4 elements Yagi with J-pole active element,
b) 3 elements VHF and 6 elements UHF antenna combined on a single boom

The VHF 4 elements antenna pattern is shown in Figure 2.

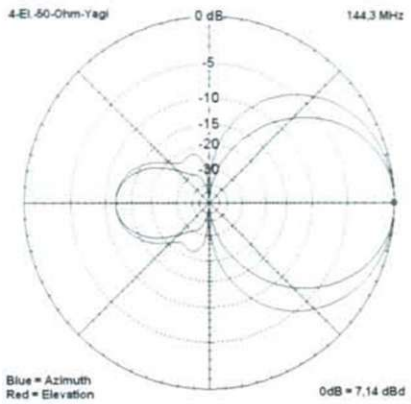


Fig 2. The VHF antenna pattern

The gain of the VHF antenna is about 7 dBd and 10 dBd for the UHF antenna, the power transfer in free space from one antenna to another can be determinate with the relationship:

$$P_R = PFD \cdot A_e = \left(\frac{G_T P_T}{4\pi r^2}\right)\left(\frac{\lambda^2 G_R}{4\pi}\right) = P_T G_T G_R \left(\frac{\lambda}{4\pi r}\right)^2$$

- λ: wavelength [m]
- P_R: power available at the receiving antenna
- P_T: power delivered to the transmitting antenna
- G_R: gain of the transmitting antenna in the direction of the receiving antenna
- G_T: gain of the receiving antenna in the direction of the transmitting antenna

The proposed warning and communication module is a radio communication link consisting of two portable communication devices with max. 5W power and two directional antennas, such the Yagi-Uda or log-periodic.

The level transducer system can be of capacitive type, with two possible solutions shown in Figure 3.

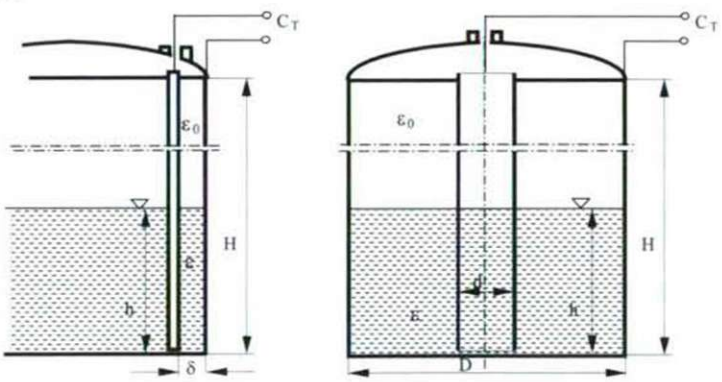


Fig 3. Capacitive level detection system

For the two level detection systems the total capacity C_T depends on the liquid level and in the first case it can be calculated with the relation:

$$C_T = C + C_0 = \frac{b}{\delta}[(\varepsilon - \varepsilon_0)h + \varepsilon_0 H] \qquad C = \varepsilon\frac{b \cdot h}{\delta} \qquad C_0 = \varepsilon_0\frac{b(H-h)}{\delta}$$

For the second type of level detection system the relationships are:

$$C_T = \frac{2\pi}{\ln\left(\frac{D}{d}\right)}[(\varepsilon - \varepsilon_0)h + \varepsilon_0 H] \qquad C = \frac{2\pi\varepsilon h}{\ln\left(\frac{D}{d}\right)} \qquad C_0 = \frac{2\pi\varepsilon_0 (H-h)}{\ln\left(\frac{D}{d}\right)}$$

A possible method for the flow and fluid velocity detection is presented in Figure 4. The flow produces a torque M_i which is measured with two transducers T_1 and T_2.

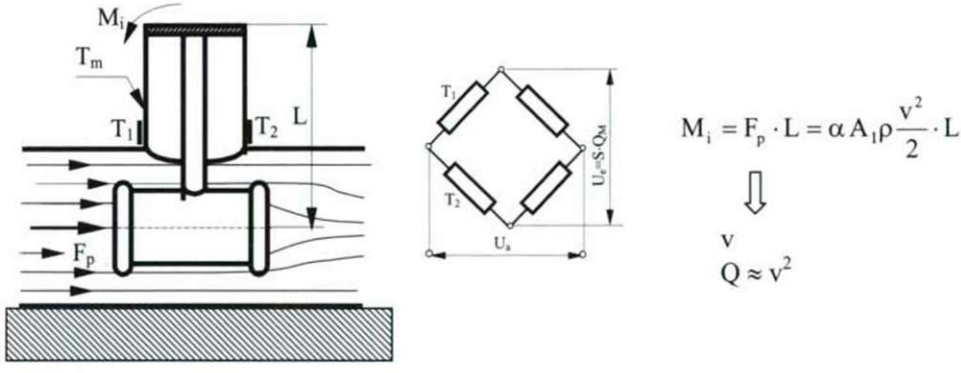


Fig 4. The flow detection system

3. EXPERIMENTAL RESULTS

In order to test the ability of the communication module an experiment was performed using Alinco DJ596E, 5W, portable radio amateur equipment and home-made 4 elements VHF Yagi antenna against the 6 elements UHF antenna. The selected region was a mountain area with dense forest. One point A was 835 m high and the second one B was at 560 m high with 5000 m in between.

The voice FM test was received with S5 on the transceiver for the 4 elements VHF antenna and only S3 for the 6 elements UHF antenna, at point B simulating the authorities point.

4. CONCLUSIONS

The performed test proves that the warning signal from the flow rate transducer provided to the communication module reaches the authorities with good intelligibility.
At a displacement speed of 4m/s for the flash flood, there is a 15 minutes reaction time. This is calculated for 5000 m line of sight distance between the A and B points. For 20 km distance line of sight there is almost one hour reaction time. This aspect becomes important when the flash flood appears during the night when the chance to observe the flood in time is drastically reduced.
The recent flash flood events affecting small villages demonstrate the necessity of such guarding devices in order to save life's and goods.

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MATHEMATICAL CORRELATIONS BETWEEN THE MAIN ALLOY ELEMENTS AND THE STEELS RESISTANCE

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ABSTRACT

Dissolving in iron, the alloy elements influence the range of austenite and ferrite. In point of influence they have over the allotropic transformation of iron, the alloy elements in the chemical composition of steel type 15VMoCr14X split into two large groups: gamma forming elements (nickel, manganese, carbon, nitrogen etc.) and alpha forming elements (chromium, molybdenum, vanadium, silicon, aluminum).

The alloy elements increase the tensile strength, but differently: Cr, Mo and V increase the resistance of ferrite less than Si, Mn and Ni. The Si, Mn and Mo decrease the resilience of ferrite, more than Ni and Cr do.

In this paper we suggest a mathematical shaping of the influence of the main alloy elements over the resistance characteristics of steel type 15VMoCr14X. It has been noticed that the alloy elements increase the tensile strength, but differently: Cr, Mo and V increase the resistance of ferrite less than Si, Mn and Ni. The Si, Mn and Mo decrease the resilience of ferrite, more than Ni and Cr do. The increase of the alloy content over 1.2% leads to a sudden fall of the resilience. The exception of this rule is nickel that both increases the resilience of ferrite and decreases the transition temperature.

Key words:
alloy elements, mechanical characteristics, mathematical shaping

1. INTRODUCTION

Most of the alloy elements dissolve in ferrite, in big proportion, forming solid substitution solutions, except for carbon, nitrogen, hydrogen and boron that have atomic radii less than those of iron and form interstitial solutions. Some elements (like nickel and cobalt) form isomorphous series of solid solutions, in any proportion, from the melting temperature to the ambient temperature; and others (chromium, molybdenum, vanadium) form, at high temperatures, solid solutions, having unlimited solubility and, when cooling, they form chemical compounds. When solid solutions are formed, the chemical properties, especially, modify and, when chemical compounds (carbides) are formed, the mechanical properties modify.
Many alloy elements, holding higher affinity with carbon than iron, dissolve in cementite, being capable of forming both alloyed cementite and special carbides. The elements situated at the left of iron in the periodical system of elements (Cr, Mn, Mo, V, etc.) form carbides. The elements that hold higher affinity with oxygen than iron form oxides. When processing steel, as a result of the oxidation process, the oxides Al_2O_3, V_2O_5 and SiO_2 can be formed. The alloy

elements that hold higher affinity with sulphur than iron form sulphides (MnS, etc.). Usually, the quantity of oxides and sulphides is small because the proportion of oxygen and sulphur is strictly limited at the alloyed steel.

Dissolving in iron, the alloy elements influence the range of austenite and ferrite. In point of influence they have over the allotropic transformation of iron, the alloy elements in the chemical composition of steel type 15VmoCr14X split into two large groups: gamma forming elements (nickel, manganese, carbon, nitrogen etc.) and alpha forming elements (chromium, molybdenum, vanadium, silicon, aluminum).

The alloy elements increase the tensile strength, but differently: Cr, Mo and V increase the resistance of ferrite less than Si, Mn and Ni. The Si, Mn and Mo highly decrease the resilience of ferrite, more than Ni and Cr do.

Manganese and nickel have the greatest influence over the decrease of elongation per unit length. The increase of the alloy content over 1.2% leads to a sudden fall of the resilience. The exception of this rule is nickel that both increases the resilience of ferrite and decreases the transition temperature.

Chromium is an alfa favoring element that, when over 12%, determines the disappearance of the γ-α range. It dissolves both Feα and Feγ, forming especially simple and double carbides, when the carbon content is sufficient. The chromium-based carbides have a higher thermal stability and it is necessary for the austenitic transformation to be made at high temperatures, as well as a long maintenance so that hardening can be possible.

The hypoeuctoid chromium alloyed steel types have a reduced harden-ability because they always contain a bigger quantity of proeutoidic ferrite.

Chromium is characterized by high temper and by the fact that it forms stable carbides that give steel high resistance to wear and makes it suitable for steel cutting. The hardening of alloyed steel is accompanied by a certain loss of its resilience and elongation per unit length. For increasing the resilience and the elongation per unit without decreasing the temper too much, nickel is added in the chemical composition of steel.

Chromium determines an increase in the steel hardening, being the third most used element, after manganese and silicon, the most used chromium alloyed steel types being the perlitic ones. We can say that:

- Chromium content lower than 1% favors the steel hardening.
- Chromium content of 1…3% increases the resistance to hydrogen under pressure and favors the nitrification process.
- As the chromium content increases, the steel becomes more and more resistant to oxidation and corrosion.
- Chromium content higher than 30% determines steel to become infusible.
- Chromium increases the temper and the resistance to wear but decreases the resilience (tenacity).

Molybdenum is an alpha favoring element, just like chromium, but weaker than silicon. The austenite range of steel is restrained in the presence of molybdenum, becoming closed at concentrations higher than 2% Mo, raising the eutectoid transformation temperature and moving it when the carbon content is lower.

Dissolved in ferrite, molybdenum hardens it and increases its resistance to creep. Molybdenum is a chemical element that reacts with carbon, forming complex iron and molybdenum carbides, even when the molybdenum content is low (0.5% Mo).

Molybdenum is twice more carbide favoring than wolfram and its diffusion speed in austenite is four times higher. This property, that determines a better homogeneity when in hot condition, determines a better machinability and tenacity of medium-carbon steel and high-carbon steel but also a higher sensitivity to the thermal treatment and decarburization.
Molybdenum very much lowers the martensitic transformation temperature (Ms), to 1.5% Mo, and decreases the softening tendency when tempering of the hardened steel types, even when the Mo content is only 0.2%.
When tempering the molybdenum alloyed steel types, it takes place a finely dispersed precipitation of some constituents similar to carbides that cancel the tempering brittleness effect, the steel types with 0.5% Mo content not having this effect anymore. Usually, molybdenum is used as an alloy element along with other elements, at processing the alloyed steel types.
Vanadium lowers the austenitic range of the iron and carbon alloys, the iron having 1% vanadium no longer suffering the transformation of α into γ. Vanadium is a highly carbide favoring element, having little stability in cementite and forming very fine vanadium carbides that have a very high hardness and hardly dissolve in austenite when heating it. That is why the vanadium alloyed steel types have a fine structure and resistance to overheating. At very low concentrations (0.04% V), vanadium very much influences the harden-ability, and at higher concentrations and at the usual hardening temperature, it decreases the harden-ability by forming sparingly soluble carbides.
Because of its capacity of forming stable nitrates with nitrogen, vanadium decreases the aging tendency of steel, especially at the extra-soft steel types, for the cold flow. At the semi-soft steel types, vanadium increases the hot flow resistance and the elastic limit.
Vanadium holds a relatively low affinity with oxygen, which means that vanadium is a weak deoxidizer, the deoxidizing effect being stronger at higher vanadium concentrations. That is why the vanadium alloying should be made at smelting, after the deoxidization was performed, in order to eliminate any loss that might occur, vanadium being a very expensive element.

2. THE RESULTS OF THE EXPERIMENTS

The chemical composition of type 15VMoCr14X steel is shown in Table no.1.

Table 1

Chemical composition, [%]	C	Si	Mn	P	S	Cr	Mo	V	Cu	Ni
Requested	0.12… 0.18	max. 0.20	0.8… 1.10	max. 0.02	max. 0.015	1.25… 1.50	0.80… 1.00	0.20… 0.30	max. 0.16	max. 0.30
Obtained	0.18	0.09	0.86	0.006	0.015	1.50	0.92	0.30	max. 0.16	-

The requested values of the mechanical characteristics, compared to those obtained as a result of laboratory tests, are shown in Table no. 2.

Table 2

Mechanical characteristics	$Rp_{0.2}$ [N/mm^2]	Rm [N/mm^2]	A_5 [%]	WU_5 [J]	KCU_5 [J/cm^2]	$R_1 \cdot 10^{-7}$ [N/mm^2]
Requested	930	1080…1280	10	39	80	500
Longitudinally	1153…1170	1240…1238	17.5…15	54.8…55.8	140…152	550
Transversally	1148…1152	1230…1240	15.75…17.5	47.1…48.1	72…50	510

For the statistical and mathematical analysis, there were used 50 industrial batches.

The average values and the average square aberration of the variables are:

Cr	1.4554	0.0762
Mo	0.8611	0.0143
V	0.2311	0.0155
Rm	1173.11	57.1896

Next, there are shown the results of the multidimensional processing of experimental data. For that purpose, we searched for a method of modeling the dependent variables depending on the independent variables x, y, z:

$$u=c_1 \cdot x^2 + c_2 \cdot y^2 + c_3 \cdot z^2 + c_4 \cdot x \cdot y + c_5 \cdot y \cdot z + c_6 \cdot z \cdot x + c_7 \cdot x + c_8 \cdot y + c_9 \cdot z + c_{10} \quad (5)$$

The optimal form of modeling, studied on a sample of 50 batches is given by the equations:

$$Rm = 252.2642 \cdot Cr^2 - 2.5251 \cdot Mo^2 + 9.4122 \cdot V^2 + 2.3667 \cdot Cr \cdot Mo + 7125 \cdot Mo \cdot V - 4.8941 \cdot V \cdot Cr - 1.0424 \cdot Cr + 7486 \cdot Mo + 2.2014 \cdot V + 3367 \quad (2)$$

where the correlation coefficient is:

$$r = 0.7489 \quad (3)$$

and the aberration from the regression surface is:

$$s = 37.8943 \tag{4}$$

This surface from the four dimensional space allows a saddle point having the following co-ordinates:

$Cr_ş = 2.2062$

$Mo_ş = 1.2399$

$V_ş = 0.4093$

$Rm_ş = 1016$

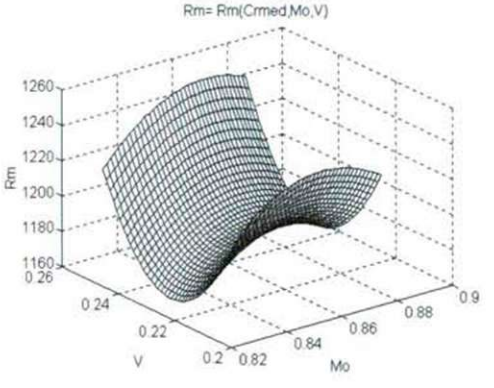

Figure 1. The surface Rm = Rm(Cr_{med}, Mo, V)

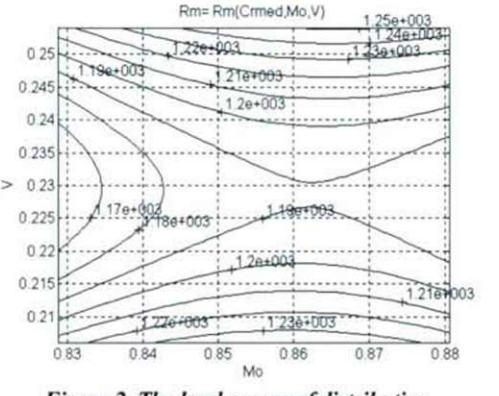

Figure 2. The level curves of distribution Rm = Rm(Cr_{med}, Mo, V)

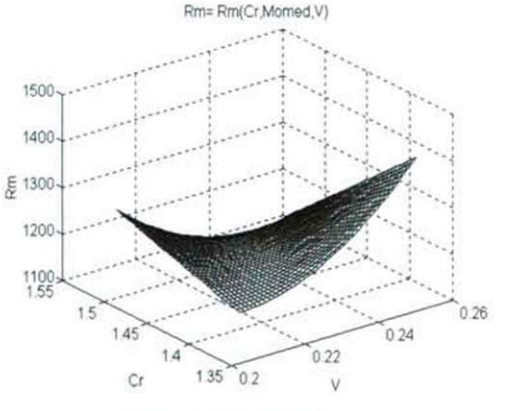

Figure 3. The surface Rm = Rm(Cr, Mo_{med}, V)

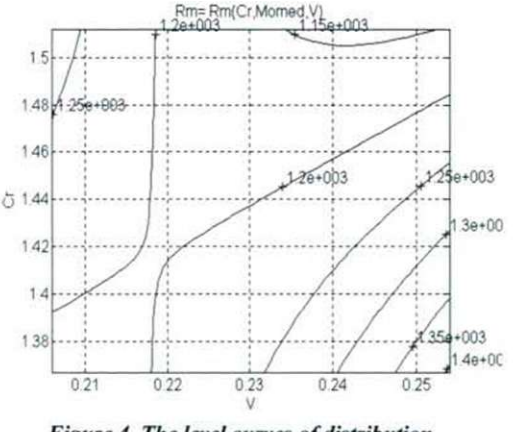

Figure 4. The level curves of distribution Rm = Rm(Cr, Mo_{med}, V)

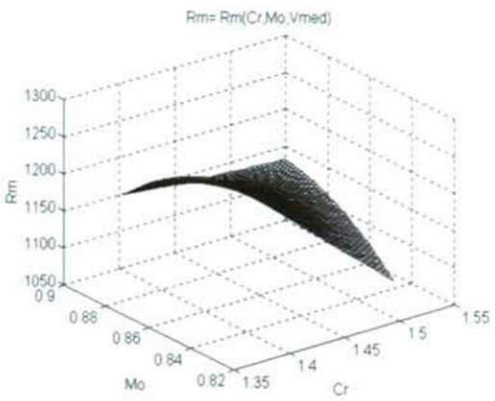

Figure 5. The surface
$Rm = Rm(Cr, Mo, V_{med})$

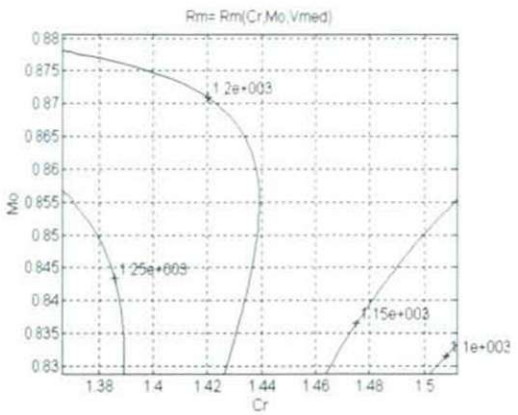

Figure 6. The level curves of distribution
$Rm = Rm(Cr, Mo, V_{med})$

3. CONCLUSIONS

The behavior of these hypersurfaces in the point where three independent variables take their average value can be studied only tabular (for example, table no.3), attributing values to the independent variables on spheres concentric to the studied point.

Because this surface cannot be represented in the three-dimensional space, the independent variables were successively replaced with their average values.

Table 3

No.	Chemical composition [%]			The tensile strength
	C	Cr	Mn	Rm, [N/mm^2]
1.	1.435	0.861	0.230	1201.1
2.	1.441	0.861	0.244	1230.0
3.	1.455	0.881	0.230	1181.1
4.	1.469	0.861	0.215	1206.8
5.	1.475	0.861	0.230	1178.7

This is how the following equations were obtained.

$$Rm_{(Crmed)} = -2.5277 \cdot Mo^2 + 9.4144 \cdot V^2 + 7125 \cdot Mo \cdot V + 4.1924 \cdot Mo - 4.9168 \cdot V - 1.1266 \quad (5)$$

$$Rm_{(Momed)} = 9.4124 \cdot V^2 + 252.2 \cdot Cr^2 - 4.8914 \cdot V \cdot Cr + 2.8144 \cdot V + 9953 \cdot Cr - 8912 \quad (6)$$

$$Rm_{(Vmed)} = 252.2 \cdot Cr^2 - 2.5254 \cdot Mo^2 + 2.3661 \cdot Cr \cdot Mo - 2.1671 \cdot Cr + 9125 \cdot Mo + 1.3419 \quad (7)$$

These surfaces, belonging to the three-dimensional space, can be represented and, therefore, interpreted by technologists. The surfaces are represented in fig. 1, 3 and 5. For a more correct quantitative analysis, in fig. 2, 4 and 6, there were represented the corresponding level lines, resulting the following conclusions: in the case of $Cr=Cr_{med}$, Rm allows a maximum for Mo=0.86 and a maximum V, and minimum values for V= 0.23 and a minimum Mo; in the case of $Mo=Mo_{med}$ a maximum can be noticed in the area where V=0.26 and Cr is minimum; when $V=V_{med}$ there can be noticed a maximum of Rm for Cr=1.33 and Mo is minimum, the minimum value being reached when Cr is maximum and Mo is minimum.

Knowing these level curves allows the correlation of the values of the two independent variables so that Rm is obtained in between the requested limits.

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COMPUTER AIDED DESIGN POSSIBILITIES OF BOLTED CONNECTION

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ABSTRACT

This paper presents a modern and efficient way of designing bolted connection, using the specialized software packages CAD/CAE. We present a case study on assembling using bolted joints, with initial clamping and loaded with transversal forces. The 3D modeling of the studied threaded assembly (parts, screw, nut and washer) and the resistance calculations for a geometric case and data load were made using the Design Accelerator module, which is part of the Autodesk Inventor Professional package. This study was performed in a transparent and easy manageable manner, offering the possibility of viewing the results and modifying the input parameters at any time. In the final stage, we obtained the tension and deformation state of the threaded assembly components using the finite element method, respectively the Algor program.

KEYWORDS
Bolted connection, computer aided design, Inventor, stress analysis, Algor

1. INTRODUCTION

Threaded assemblies can be placed in the category of removable assemblies, and are made using standard machine parts (screws, nuts, washers). These assemblies are classified according to several criteria, such as their adjusting and the direction of the stress force. This paper presents some design and analysis possibilities for threaded assemblies loaded with transverse forces.

A characteristic of these assemblies is that the external forces have directions perpendicular to the screw axis. Such assemblies can be constructed in two ways: screw mounted without clearance (adjusted housing or matched) and screw mounted with clearance (or unmatched).

As these joints are commonly used in machine construction, their design implies detailed calculations, taking into account the conditions under which these machines operate.

Through continuous development of the CAD/CAE computer programs, the design of screw assemblies (the geometrical modeling and the calculation of resistance) can be made in a transparent and easy manageable manner, offering the possibility of viewing the results and modifying the input parameters at any time.

The assembly studied in this paper is a device for testing the bolted connections, with screws mounted with clearance and initial clamping loaded with transversal forces. The design and the finite element analysis of the assembly are performed using the computational packages CAD/CAE Inventor Professional, and Algor.

2. PARAMETRIC MODELING OF THE THREAD ASSEMBLY

The assembly provides the mounting of two pieces by two splice plates with three bolted connections, arranged according to fig. 1.

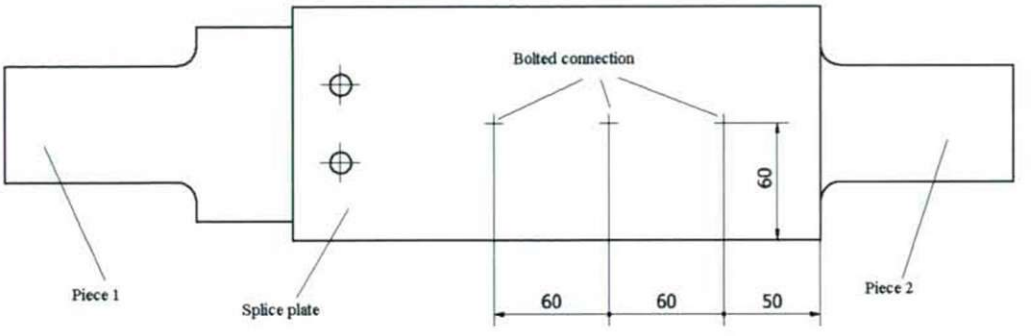

Fig.1. The bolted connection arrangement

The geometric (parametric) modeling of the three bolted connections was done using the Design Accelerator - Bolted Connection Generator module, from the Autodesk Inventor Professional program. The modeling involves inserting holes, screws, washers and nuts from the programs library of symbols, in agreement with the valid standards (fig. 2) for user-defined bolt diameter (M10), by specifying their insertion points (fig. 1) and limiting surfaces.

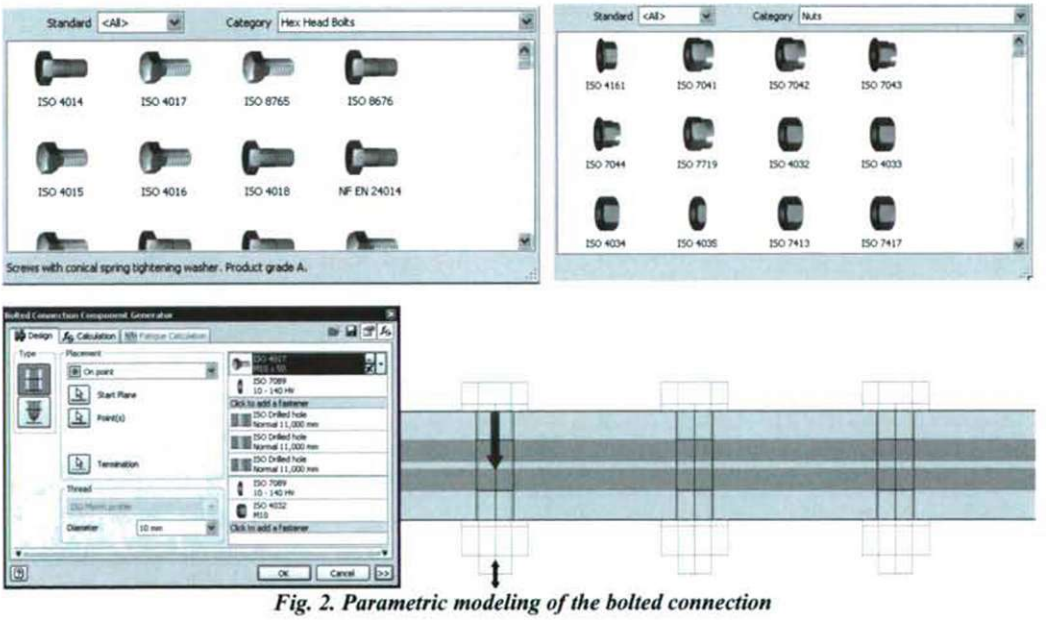

Fig. 2. Parametric modeling of the bolted connection

A section of the resulting parameterized 3D model of the assembly is shown in fig. 3.

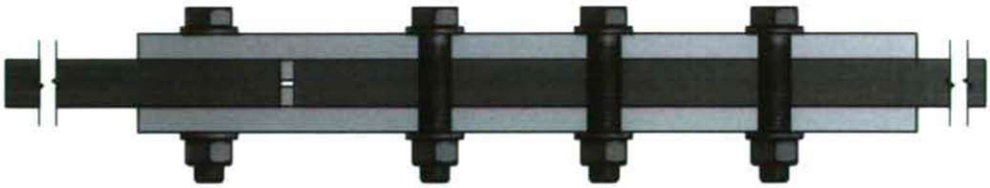

Fig. 3. Geometrical model of the assembly (2D section)

3. CALCULATION OF THE THREAD ASSEMBLY LOADED WITH TRANSVERSAL FORCES

In the case of assemblies made with screws mounted without clearance (Fig. 4), the transversal load on the screw is passed to the bolt of the screw, which will be loaded with shear and contact stresses. The relations used in the calculation are listed below:

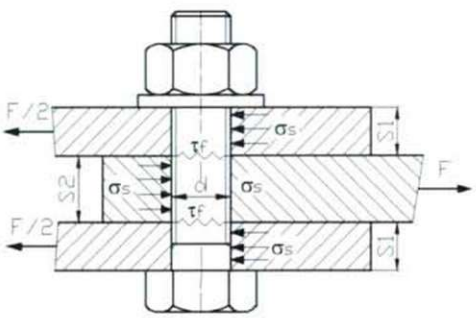

Fig. 4. Assembly with screws mounted clearance, loaded with transversal forces

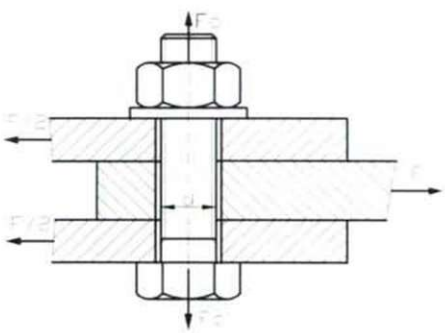

Fig. 5. Assembly with screws mounted with without clearance, loaded with transversal forces

Check to shear (determines the necessary diameter of the screw shaft):

$$\tau_f = \frac{4F}{i \cdot \pi \cdot d^2} \leq \tau_{af} \qquad d_{nec} = \sqrt{\frac{4F}{i \cdot \pi \cdot \tau_{af}}}$$

Check to stress:

$$\sigma_s = \frac{F}{s \cdot d} \leq \sigma_{as}$$

In the case of screw assemblies made with clearance (fig. 5), the transverse load F is carried by frictional forces, which occur between the parts closed with the initial clamping force F_0. This force must ensure a mutual fixing of the parts by friction and its total value is:

$$F_f = \mu \cdot i \cdot F_o ,$$

While the fixing condition is given by:

$$F_f \geq \beta \cdot F,$$

where: β is a safety coefficient.
Substituting the value of the friction force, we obtained the clamping force Fo which ensures the contact between the pieces, respectively the screw tension:

$$F_o = \frac{\beta \cdot F}{\mu \cdot i} \qquad \sigma = \frac{4 \cdot 1{,}3 \cdot F_o}{\pi \cdot d_1^2} \leq \sigma_{at}$$

The additional torsion load of the assembly was also taken into account, through the coefficient 1.3.
These calculations of strength (checking or sizing) can be performed faster using the Bolted Connection Generator application from the Autodesk Inventor program. For the three bolted connections defined in paragraph 2 (fig. 2), we chose the option of checking the calculation, imputed the values of the forces that load the assembly, respectively of some coefficients specific to the threaded assemblies, and then chose the materials for the parts and screw. The geometrical dimensions of the thread were automatically uploaded. The interface with the Calculation tab is presented in fig. 6. As a result of the calculation, the program returns a message which validates or not the design.

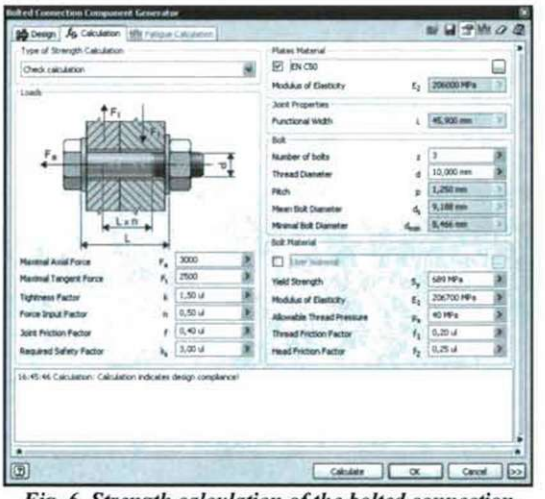

Fig. 6. Strength calculation of the bolted connection

4. ASSEMBLY ANALYSIS USING THE FINITE ELEMENT METHOD

The analysis of mechanical systems using the finite element method is a mathematical solution to engineering problems, which is based on dividing the studied bodies in discrete (finite) elements, in form of cubes and tetrahedrons. The analysis by finite element method allows us to determine the distribution of the stresses, specific deformations, movements, vibration analysis, for a loaded data and related constrains.
The analysis of mechanical systems by finite element method is carried out either through a rather complex matrix calculation, or using dedicated software packages such as: Algor,

Ansys, and Cosmos. In the following, the static analysis of a threaded assembly using the Algor program is presented.
As the Algor program allows modeling bolted connections as links between the assembled parts, we will use in this study a simplified 3D model, without the three bolted connections (only with holes for the screws), as shown in Fig. 7.
The modeling of bolted joints is achieved through defining the dimensions of the connection, respectively the surfaces between which the connections are made. The 3D model thus defined is presented in Fig. 8.

Fig. 7. Assembly simplified model

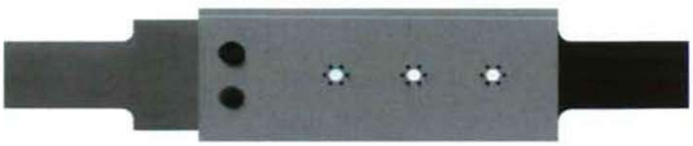

Fig. 8. Threaded assembly model

In the following, the specific stages of an analysis using the finite element method are presented, namely meshing the model, defining the type of elements and materials for each component of the assembly, that define the boundary condition and external loads. The final model for analysis is presented in fig. 9. Note that a contact surface was defined between the assembly parts, as there is friction between them (coefficient of friction $\mu = 0,1$).

Fig. 9. The final model used for analysis

After the analysis is performed, we visualize and evaluate the results, such as von Misses stress distribution of the assembly (Fig. 10), the reaction forces and the axial stress of the bolted connection elements (Fig. 11, Fig.12).

Fig.10. Stress distribution in the elements assembly

Fig. 11. Reaction force from the bolted connection elements

Fig. 12. The axial stresses in the bolted connection elements

5. CONCLUSIONS

The computer aided design of threaded assemblies, made with bolts fitted with clearance and initial clamping loaded with transversal forces, is an efficient, interactive, computationally cheap and fast way to design.
The results obtained by finite element analysis are comparable to those obtained in the laboratory using a real device.

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ANALYSIS OF FORECASTING METHODS REGARDING CIRCULATION OF GOODS, BASED ON THE EXAMPLE OF COMPANY KOCHLOEFFEL POLSKA SP. Z O.O

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ABSTRACT

The storage problems of food products, which result from seasonal variations in demand are discussed in the paper. Selected forecasting methods were examined in the context of efficiency. Due to seasonal demands the analysis was focused on forecasting methods regarding seasonal fluctuations. There were used Winter's model, seasonality indices and harmonic analysis. To determine coefficients in harmonic analysis, an analytic method as well as artificial immune systems was selected. The results of each calculations were put together and compared.

1. INTRODUCTION

Nowadays the activities of corporation, as well as every human initiative are exposed to intense competition. It is necessery to accurately predict what could possibly happen on the market. To predict demand variations regarding corporation's products and services, forecasting methods are used which make the demands predictions scientifically grounded. [1]. Inadequate decisions result with massive, unnecessary financial costs, which could be due to wrong preparation to current situation.

The process implementation of forecasts into company operations is multiphased and requires many initial assumptions. Wrong forecast in relation to current situation could lead to serious consequences. It could be too little goods storage in the warehouses in relation to requirements of appropriate clients or on the contrary too much accumulation of goods which leads in so-called freezed capital [4].

The article examined efficiency of selected forecasting methods, based on the example of corporation Kochloeffel Polska Sp z o.o.

2. CHARACTERISTICS OF THE CORPORATION KOCHLOEFFEL POLSKA SP Z O.O.

Kochloeffel Polska Sp z o.o. is a fast-food restaurant network. It functions on the Polish market since 1995. Currently the company has 8 restaurants in Poland, all located in the Silesian voivodship.

There rotation of foods in the company is quite frequent. The restaurants have medium sized warehouse resources and the products time of expiration is short, therefore it is very important

to order the appropriate amount of them. The ordering process for all products, during every season of the year is estimated from formula:

$$Z_n = X_{sr} \cdot d - S_m - Z_{n-1} \quad (1)$$

where:

Z_n – current order; X_{sr} – average sale from previous days (last 14 working days); d – amount of days the order is realized for; S_m – amount of goods in the warehouse (current); Z_{n-1} – previous order.

This is quite a simplified ordering formula. The above pattern is not going to work if the sale of one of the products goes according to a trend or seasonal fluctuations. Forecast built on the average sale from the previous period tends to be delayed, if the demand has a constant increase or decrease. Due to company form of activity (gastronomy) sale of majority products is characterized by certain fluctuations. The demand for a product depends on the season of the year and the climatic changes. The implementation of appropriate forecast model to the system of order supply management allows to optimize warehouse supply and lowers the costs of goods storage.

3. SELECTED FORECASTING METHODS

The forecasts that were made, were based on the french fries sale in years 2006-2008 in "Conieco" restaurant located in Tarnowskie Góry. Table 1 there are monthly sales from this period, and figure 1 presents chart of french fries sale. As it is possible to observe the sale of french fries is characterized by seasonal fluctuations and some repetitions. The lowest demand is visible in the winter period. In September of all years a considerable increase in sale can be seen. This products is not an exception, the other goods have the largest sale in September too. It happens because in the middle of September a 3 day long festival named "Gwarki" takes place in Tarnowskie Góry. During the fair a significant increase in sale of all products can be observed.

Table 1 Monthly sale of french fries [kg] in years 2006-2008

Year 2006	Sale [kg]	Year 2007	Sale [kg]	Year 2008	Sale [kg]
January	1458	January	1724	January	1761
February	1339	February	1598	February	1716
March	1633	March	1984	March	1942
April	1945	April	2280	April	2137
May	2190	May	2087	May	2103
June	2243	June	2326	June	2170
July	2023	July	2254	July	2309
August	2276	August	2496	August	2473
September	2731	September	2941	September	3122
October	2133	October	2047	October	2273
November	1796	November	1572	November	1958
December	2054	December	1971	December	2270

To analyze a time sequence characterized with seasonal fluctuations a few forecasting methods were used. Their measurement of efficiency are forecast errors. Provided that larger supplies are concerned with accumulating goods in the warehouse and „freezing" money spent

on them, shortage of supplies is connected with immediate break of sale, which leads to loss of possible profits. It is accepted that forecast error should never be negative (shortage of supplies). On the other side permitted positive forecast error should be as small as it is possible. To analyze the sale of french fries in years 2006-2008, methods were used [1]:

- seasonal indices
- Winter's
- harmonic analysis

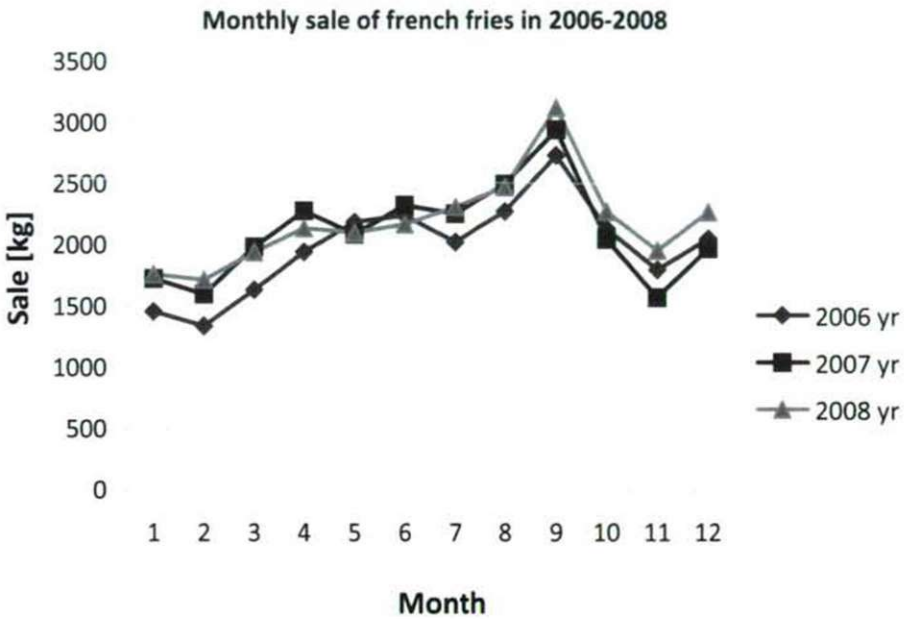

Figure 1. Monthly sale of french fries [kg] in years 2006-2008

In addition the first two methods were divided to additive and multiplicative models. Expired forecasts for additive model in seasonal indices metod were calculated from formula:

$$y_{ti}^{*} = \hat{y}_{ti} + s_i \tag{2}$$

where:

y_{ti}^{*} - forecast for moment / period t,

$\hat{y}_{ti}$ - theoretical values of forecasted variable calculated from trend model, which is expressed by function:

$$\hat{y} = 12{,}832x + 1855{,}3 \tag{3}$$

Seasonal indices in additive model are calculated from:

$$s_i = z_i - \frac{1}{r}\sum_{i=1}^{r} z_i \tag{4}$$

where:
s_i – seasonal indicator for i-phase of cycle; r – number of phases in cycle;
z_i – crude indicators of seasonality y.
For multiplicative model the formulas are very similar:

$$y_{ti}^{*} = \hat{y}_{ti} \cdot s \tag{5}$$

$$s_i = \frac{z_i}{q} \tag{6}$$

Forecasts for time moment t for additive model in Winter's method were calculated from formula:

$$y_t^{*} = F_{t-1} + S_{t-1} + C_{t-r}, \qquad \text{for } t > r \tag{7}$$

where:
smoothed assessment of level (average value) for moment/time period t:

$$F_t = \alpha \cdot (y_t - C_{t-r}) + (1-\alpha) \cdot (F_{t-1} + S_{t-1}) \tag{8}$$

smoothed value of trend growth for moment/time period t:

$$S_t = \beta \cdot (F_t - F_{t-1}) + (1-\beta) \cdot S_{t-1} \tag{9}$$

assessment of the seasonality index for moment/time period t:

$$C_t = \gamma \cdot (y_t - F_t) + (1-\gamma) \cdot C_{t-r} \tag{10}$$

where:
y_t - value of forecasted variable for moment/period t; α - smoothing level parameter of forecasted variable with values in range $(0,1] \rightarrow \alpha \neq 0$; β - parameter of growth smoothing caused by development tendency with values in range $(0,1] \rightarrow \beta \neq 0$; γ - parameter of seasonality index assessment with values in range $(0,1] \rightarrow \gamma \neq 0$; r - seasonal cycle length (number of phases of each cycle).
For multiplicative model the formulas are as following:

$$F_t = \alpha \cdot \frac{y_t}{C_{t-r}} + (1-\alpha) \cdot (F_{t-1} + S_{t-1}) \tag{11}$$

$$S_t = \beta \cdot (F_t - F_{t-1}) + (1-\beta) \cdot S_{t-1} \tag{12}$$

$$C_t = \gamma \cdot \frac{y_t}{F_t} + (1-\gamma) \cdot C_{t-r} \tag{13}$$

$$y_t^{*} = (F_{t-1} + S_{t-1}) \cdot C_{t-r}, \qquad \text{for } t > r \tag{14}$$

In forecasting using harmonic analysis, the harmonic function changes it's form. The way it changes depends whether in the time series occur random fluctuations around constant level

and trend. In case the time series has a certain development tendency and seasonal fluctuations, model of the harmonic analysis can be presented as sum of the harmonics [2,5]:

$$y_t = f(t) + \sum_{i=1}^{n/2}[\alpha_i \sin(\frac{2\pi}{n} it) + \beta_i \cos(\frac{2\pi}{n} it)] \quad (15)$$

where:

$f(t)$ - linear function of trend in accordance with formula (2); i - harmonic number; α_i, β_i - parameters; n - number of measurements (months).

For time series with number of observations equal to n, number of harmonics is $\frac{n}{2}$. Analysis includes n=36 months, so there are 18 harmonics in the model. To determine them, values a_i and b_i for individual harmonics are needed.

$$a_i = \frac{2}{n} \cdot \sum_{t=1}^{n} y_t \cdot sin\left(\frac{2\pi}{n} it\right), i = 1,\ldots,\frac{n}{2} - 1 \quad (16)$$

$$b_i = \frac{2}{n} \cdot \sum_{t=1}^{n} y_t \cdot cos\left(\frac{2\pi}{n} it\right), i = 1,\ldots,\frac{n}{2} - 1 \quad (17)$$

In addition to calculate share variance of forecasted variable by individual harmonics, indices were calculated:

$$\omega_i = \frac{a^2 + b^2}{2 \cdot s_{\bar{y}}^2} \quad for \;\; i = 1,2,\ldots,\frac{n}{2} - 1 \quad (18)$$

$$\omega_i = \frac{a^2 + b^2}{s_{\bar{y}}^2} \quad for \;\; i = \frac{n}{2} \quad (19)$$

where:

$s_{\bar{y}}^2$ - ariance of time series with eliminated trend.

Harmonics with numbers 1, 3, 6, 9 and 12 have a total share of 93,23%. The forecast model was simplified to consist only 5 most important harmonics of the formula:

$$y_t^* = 1855{,}3 + 12{,}832 \cdot t + 96{,}36 \cdot \sin(\frac{2\pi}{36} t) - 32{,}61 \cdot \cos(\frac{2\pi}{36} t) - 277{,}28 \cdot \sin(\frac{2\pi}{36} 3t) -$$
$$- 236{,}73 \cdot \cos(\frac{2\pi}{36} 3t) - 30{,}41 \cdot \sin(\frac{2\pi}{36} 6t) - 127{,}17 \cdot \cos(\frac{2\pi}{36} 6t) + 159{,}83 \cdot \sin(\frac{2\pi}{36} 9t) + \quad (20)$$
$$+ 101{,}45 \cdot \cos(\frac{2\pi}{36} 9t) + 43{,}01 \cdot \sin(\frac{2\pi}{36} 12t) + 176{,}78 \cdot \cos(\frac{2\pi}{36} 12t)$$

Forecasting errors of french fries sale for all models were put together in table 3 and figure 2.

4. APPLICATION OF ARTIFICAL IMMUNE SYSTEMS IN FORECASTING

The model of harmonic analysis described In point 2 could also be expressed as following:

$$y_t = a_0 + a_1 t + \sum_{i=1}^{m} [a_{2i} \sin(\frac{2\pi i}{n} t) + a_{2i+1} \cos(\frac{2\pi i}{n} t)] \quad (21)$$

Coefficients a_j, j=0, 1, 2, ...2m+1 of harmonic function can be selected using the artifical immune systems.

Artifical immune systems are algorithms which simulate the behavior of defense systems found in most living organisms. Natural immune system is the resistance of living organisms to bacteria and other external regimes [9]. It is also known as the immune system which has the ability to learn and adapt to changing environment. The living organism's defense system involves lymphocytes B and T. The antibodies are formed from lymphocytes B which are adapted to fight the antigen by cloning, mutation and selection. Immune system can be divided generally to nonspecific immunity (congenital) and specific immunity (adaptive). The type of congenital does not evolve or modify. Cells of the nonspecific immunity protect the organism until the adaptive immunity cells are developer. It is an immunity that evolves over time. The system also stores information about past threats.

Artificial immune systems are build on the model of the natural immune system. [4, 7, 8]. Artificial immune systems mimic the process of antibodies production by B lymphocytes. Antigen is the problem solved, on the other hand the solution is the antibody best suited to antigen and preferably recognizing it. The measure of fit is the objective function that is equal to the inverse of the errors from (22), (23) and (24). It is larger the smaller the forecast error is. Antibodies can be generated in many ways. In the used algorithm, antibodies are sets of coefficients $\{a_i : i = 0, 1, ... 2m+1\}$, which are real numbers drew from predefined intervals.

The whole process of determining the function's coefficients (21) goes through clonal selection. The base population is subjected to cloning. New antibodies are subjected to mutation which slightly changes them. For each antibody and it's clone the value of adaption function is determined. Then these values from every antibody and it's mutant clone are compared. The worse from the pair are removed. The next step is suppression . For each antibody the most similar ones are found and the worse are replaced with new ones.

The calculations were made for various numbers of parameters and different criteria. At the beginning of the calculations, some limiting ranges were made. The calculations were repeated several times at set conditions. Among the obtained results the best one was selected – the one with the smallest error value, which was taken as a criterion of optimization. If the parameter achieved to the extreme value of the interval, the boundaries were moved. If the parameter value changed in a narrow range, the boundaries were modified to surround those values. This pattern was repeated, until there was no visible improvement in the results obtained. Then the number of parameters were increased or decreased to compare with previous calculations. Some results obtained with artificial immune systems algorithm are presented in table 2.

5. DISCUSSION OF CALCULATIONS - COLLATION OF RESULTS

To compare individual forecasting methods, the most common ex post errors were used. MAE (Mean Absolute Error), RMSE (Root Mean Square Error) and MAPE (Mean Absolute Percentage Error):

1) Mean Absolute Error

$$MAE = \frac{1}{n}\sum_{t=1}^{n}\left|y_t - y_t^*\right| \tag{21}$$

2) Root Mean Square Error

$$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(y_t - y_t^*)^2} \tag{22}$$

3) Mean Absolute Percentage Error

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\frac{\left|y_t - y_t^*\right|}{y_t}\cdot 100\% \tag{23}$$

where:

n – number of cases (observations); y_t – value of time series for a moment/period of time t; y_t^* – predicted value of y for a moment/period of time t.

The results presented in table 2 were obtained using variant of optimization =2 (oriented on MAPE error). The comparison had sense only when referred to one type of error. During the calculations it was observed that with increasing number of parameters the ex post errors were decreasing.

Table 2 Some results obtained with artificial immune systems algorithm

Nr of calculation	Nr of parameters	Generation	Time [s]	Ex post error		
				MAE	MRSE	MAPE
1	20	4262	13	105	161	4,63%
2	26	8837	38	55	83	2,49%
4	38	933	4	33	46	1,56%

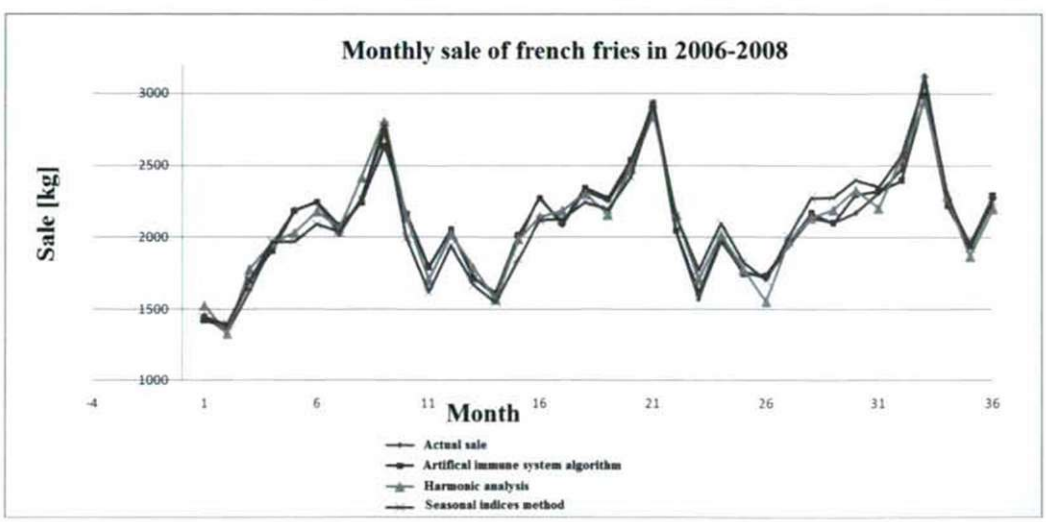

Figure 2. Comparison of expired predictions for model of seasonality indicators, harmonic analysis and artificial immune systems algorithTable 3 Summary of ex post errors for individual forecasting methods

Ex ante error	Seasonality Indicator Method		Winters method		Harmonic analysis	Artificial immune systems
	Additive model	Multiplicative model	Additive model	Multiplicative model		
MAE	85	89	167	266	**75**	**33**
RMSE	106	109	211	349	**91**	**46**
MAPE	4,19%	4,43%	8,14%	12,68%	**3,61%**	**1,56%**

The smallest MAPE error that was obtained was 1,56% in the algorithm of artificial immune system for 38 parameters. Comparing to harmonic analysis (3,61%), the error is smaller by 2,05%. Applicationof artificial immune systems to determine the coefficients of harmonic function gave the best forecasting model from among those that were used in this work.

6. SUMMARY

The article examined the effectiveness of selected methods of forecasting demand based on the example of company Kochloeffel Polska Sp z o.o. and monthly sale of french fries in years 2006-2008. Six forecasting models were presented: Winters method – additive and multiplicative model, seasonality indicators – also additive and multiplicative model and harmonic analysis with it's coefficients determined analytically and using artificial immune systems. Of all the forecasting methods used in this work, the most accurate was harmonic analysis with the coefficients of the harmonic series determined using artificial immune systems. In this forecast MAPE error was 1.56% over three years. The Winters method turned out to be the worst , and in particular the multiplicative model, for which the MAPE error was 12.68% over three years.

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EFFECT OF PRE-TREATMENT SOLUTIONS OF DRIED APPLE SLICES FROM SEVERAL CULTIVARS

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ABSTRACT

Apple is the most popular fruit in Hungary. After grape it is grown in the largest quantity. It has high health benefits, because apples contain many types of phenolic acid derivatives, flavonoids, and dietary fibres. Apples have important role of the fruit consumption in Hungary by fresh fruit and processed apple products.

Next to the fresh fruit consumption processing of apple is very important. It can be processed for pulp, dried slices (chips), juice, and concentrate. Nowadays dried slices (apple chips) have increasing tendency because consumers turn to the healthier crunches without chocolate, sugar, colorants, and preservatives. Dried apple slices match to these requirements.

The processing technologies have large and fast advance, food industry has focused on the development of new processing technologies for minimally processed fruit and vegetable. Food industry requires new apple candidates for processing technologies, as the well-known traditional varieties became old as indicated by its poor quality. In Europe a lot of country deals with selective breeding of apples. In Hungary an apple breeding program was started in the beginning of the '90s in order to widen the selection of Hungarian apple cultivars. Recently several Hungarian multi-resistant apple candidates are available for processing technologies. They are promising because of the smaller scale use of pesticides (environmental friend technology), and they have similar fruit quality to the commonly grown susceptible

In this study several types of apples (multi-resistant and common apple cultivars) were used for drying. To inhibit of the enzymatic browning ascorbic and citric acid were applied. It was investigated that it can be produce apple chips from these apple candidates without using sulphur. The main purpose of this study was to investigate the effect of pre-treatment solutions.

Apple chips were appreciated by sensory analysis. The texture by Brookfield Texture Analyser and colour was determined according to C.I.E.LAB system (L*,a*,b*) using a tristimulus colorimeter.

According to the results, chips from cultivar "Idared" with treatment ascorbic acid was the best one, chips from candidate "MR-10" follow it. Under the sensory value we drawn conclusion that dried apple slices treated by citric acid are better, particularly the colour values. It was found that all of the apple candidates are suitable for dried apple producing.

It can be state without using sulphur in drying technology it can be produce dried apple chips with good quality and convenient colour.

1. INTRODUCTION

Apple is the second widely cultivated fruit in Hungary. Commercially, apples can be stored for some months in controlled-atmosphere chambers and they have good qualitiy under storage also. Fruit industry would like to process better quality fruits and vegetables, costumers would like to consume healthier foodstuffs without any additives.

Nowadays old apple cultivars are often oddly shaped, russeted, and have a variety of textures and colours. They have other problems which make them commercially unviable, such as low yield, liability to disease, or poor tolerance for storage or transport. Because of this and the requires of the food industry and consumers desired qualities in modern commercial apple breeding are a colourful skin, absence of russeting, ease of shipping, lengthy storage ability, high yields, disease resistance. In Europe several country deals with selective breeding against different fruit diseases. An apple breeding program was started in the 1990s at Faculty of Horticultural Science, Corvinus University of Budapest, Hungary in order to widen the selection of Hungarian apple cultivars for table, industrial processing, or dual-purpose (Tóth, 1994).

Apple has widely processing opportunities. It can be processed for pulp, dried slices (chips), juice, and concentrate. Clarified apple juice is one of the most consumed juices in the world. Dried apple slices have increasing tendency, because they are healthier than chips were fried in oil, they do not content any food additives.

Drying as a preservation method for foods has been practised since the earliest times recorded history. Dried fruits show increasing tendency because they are a rich source of other antioxidant compounds which may be cancer-protective. The predominant phenolic phytochemicals in apples are quercetin, epicatechin, and procyanidin B2. The fiber content, while less than in most other fruits, helps regulate bowel movements and may thus reduce the risk of colon cancer. They may also help with heart disease, weight loss, and controlling cholesterol, as they do not have any cholesterol, have fiber, which reduces cholesterol by preventing reabsorption, and are bulky for their caloric content, like most fruits and vegetables.

In our work we focused drying several Hungarian multi-resistant and control cultivars. Two pre-treatment solutions were used to inhibit the enzymatic browning. Sulphur was not used in the experiments. Our purpose was to evaluate the quality of the dried slices, and investigate producing apple chips without Sulphur.

2. MATERIALS AND METHODS

2.1. Materials

Apple varieties and candidates were harvested in 2009 at Experimental Orchard of the Faculty of Horticultural Science, Corvinus University of Budapest, Hungary. All of the samples were in same maturity.

Dried apple slices (chips) were manufactured from four multi-resistant candidates (MR-03, MR-09, MR-10, MR-12) and two conventional, control varieties: Idared and Jonathán. Before the experiments, the apples were stored at 3°C and 90% relative humidity.

2.2. Methods

2.2.1. Composition of raw materials was determined by measuring the water soluble dry matter (Codex Alimentarius 3-1-558/93), total acid expressed in malic acid (H. St. No. 3619:1983), pectin content (Dietz és Rouse, 1953) total polyphenol content by Folin-Ciocalteau method according to Singleton and Rossi (1965).

2.2.2. Pre-treatments

Two types of pre-treatment were applied to the apple slices:

(a) Soaking of the apple slices in ascorbic acid solution of 1%, 1 min. at room temperature

(b) Soaking of the apple slices in citric acid solution of 1%, 1 min. at room temperature (Son et. al, 2001)

2.2.3. Drying method: in every case were 70°C, 6 hs

2.2.4. Examinations of the products

Colour parameters were determined according to C.I.E.LAB system (L*,a*,b*) using a tristimulus colorimeter (Konica Minolta CR 410, Minolta Canada Inc., Mississauga, ON). Texture was investigated by Brookfield, LFRA 4500 Texture Analyser. Sensory evaluation was performed according to H. St. 7304/3-86 and 1801:1989. with special regard to the colour.

3. RESULTS AND DISCUSSION

3.1. Results of raw materials

Refraction and pH values can be seen in Table 1. They showed similar values in range of 12,2-14,6 and 3,4-3,6.

Table 1. Refraction and pH values

	Refraction	pH
MR-03	**12,2**	**3,4**
MR-09	**14,6**	**3,5**
MR-10	**13,4**	**3,58**
MR-12	**12,8**	**3,5**
Idared	**13,9**	**3,57**
Jonathán	**13,9**	**3,6**

Fig. 1 shows the titratable acid content expressed in malic acid. Acidity of apples is an important quality factor because of the convenient sugar-acid ratio, and comfortable flavour.

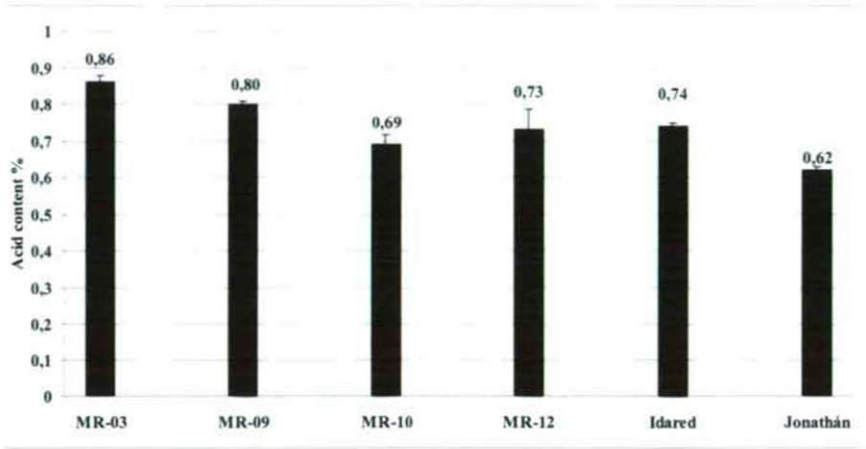

Figure 1. Acid content of the samples

Acid content of apple candidates and varieties was between 0,62 and o,83 %. The highest acid content (0,83 %) was observed in case of candidate MR-03 indicating that it. The variety of Jonathán has the smallest acid content (0,62 %).

Pectin content is shown in **Fig. 2**. It can be seen that candidates MR-03 and MR-10 have the highest pectin content. The control varieties have the smallest pectin content, and they have similar values. Pectin is very important in apples because the have important role in texture.

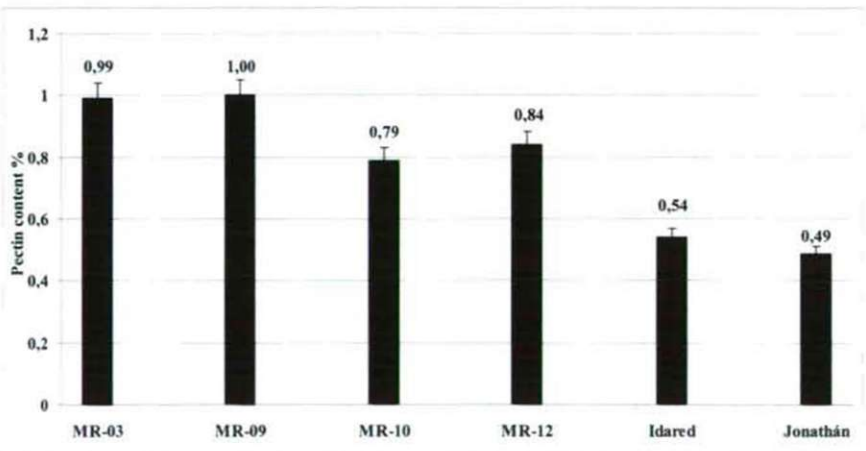

Figure 2. Pectin content of the samples

Polyphenol content was shown in Fig. 3. Candidates have polyphenol content in range 888-1105 mg/l.

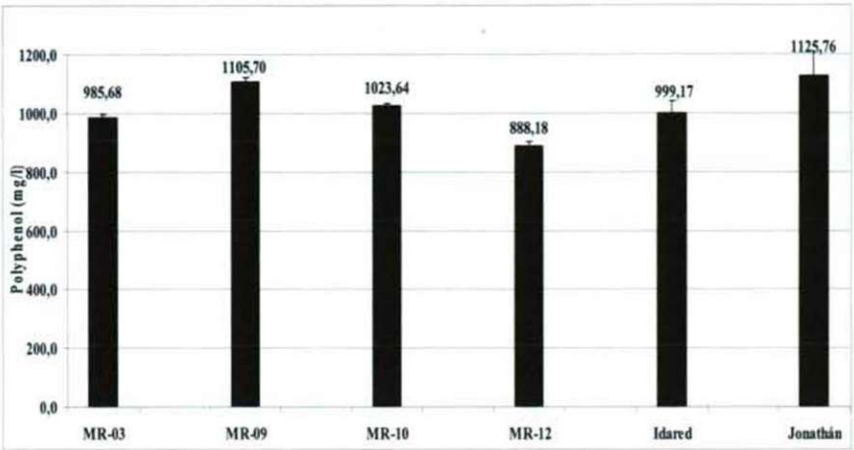

Figure 3. Polyphenol content of the samples

3.2. Evaluation of the products

In Table 2. shows the best points of the samples during sensorial analysis. It can be seen that except the colour, the best points were given to the products pre-treated by ascorbic acid.

Table 2. Sensorial best points of the products

	Best points	Sample
Colour	17.67	Jonathán citric acid
Odour	6.86	MR-10 ascorbic acid
Flavour	35.40	Idared ascorbic acid
Texture	18.40	Idared ascorbic acid
General aspect	8.29	Idared ascorbic acid

In evaluation of the products the main respects were the colour and texture. By the results of colour measurement it can be seen, that dried slices which were pre-treated by citric acid are the lightest samples (Table 3.). Slices pre-treated by ascorbic acid have reddish tint. It was shown by the high a* values (Table 4.).

Table 3. L values of the samples*

L* values	Control	Citric acid	Ascorbic acid
MR-03	83,66	***84,79***	82,12
MR-09	***82,79***	75,76	70,78
MR-10	82,62	***85,05***	70,80
MR-12	77,13	***81,34***	64,10
Idared	78,49	***80,14***	77,33
Jonathán	78,40	80,51	***86,45***

Table 4. a values of the samples*

a* values	Control	Citric acid	Ascorbic acid
MR-03	0,48	-1,34	1,72
MR-09	0,66	4,42	***16,17***
MR-10	0,54	-1,28	***15,19***
MR-12	5,34	0,83	***16,13***
Idared	3,17	3,36	***5,45***
Jonathán	2,70	3,01	-3,18

In case of total colour difference (Fig. 4) it can be seen, that products pre-treated by citric acid have higher ΔE* values. Every case the control sample was the un-treated products.It means, the colour of these products have high colour differences to the un-treated products. They have better and lighter colour. If we evaluate this it can be seen (Table 4.), that the colour differences are visible, except in case MR-03 pre-treated by ascorbic, because this difference is markable.

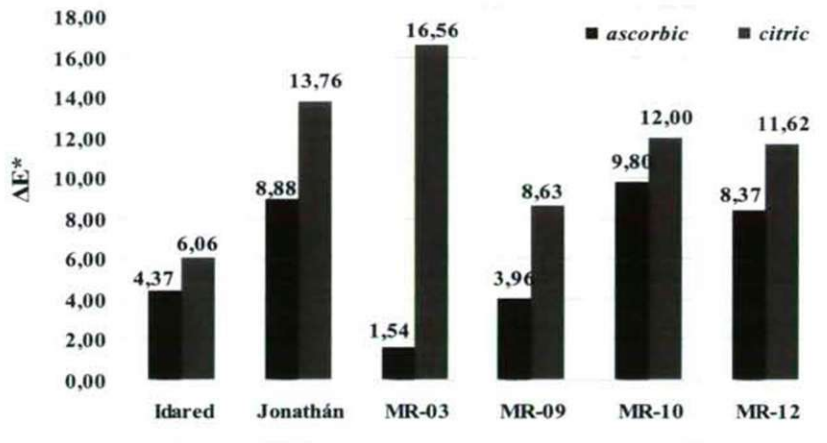

*Figure 4. Values of ΔE **

Table 4.Evaluation of total colour differences

ΔE * values	Percept Difference
0-0.5	Non markable
0.5-1.5	Less markable
1.5-3.0	Markable
3.0-6.0	Visible
6.0-12.0	High

In the course of texture examination, hardness, adhesion, and elasticity were measured, because in the evaluation of the quality of dried apple slices these parameters are important aspects. Fig. 5. shows a texture profile.

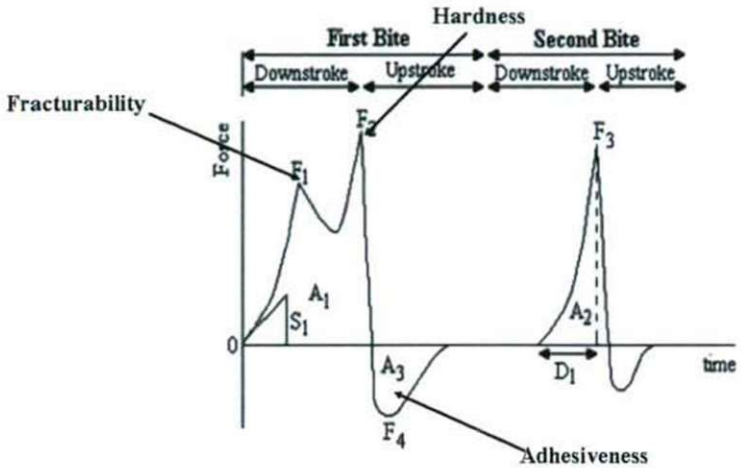

Figure 5. Texture profile

Hardness is the measure of how resistant solid matter is to various kinds of permanent shape change when a force is applied.
Because texture was get the highest points during sensorial analysis in case of samples pre-treated by citric acid, these texture values are shown in Fig. 5. it can be seen, hardness values are between 242-386 g. The hardest sample is purchased one, and the softest one is variety Jonathán.

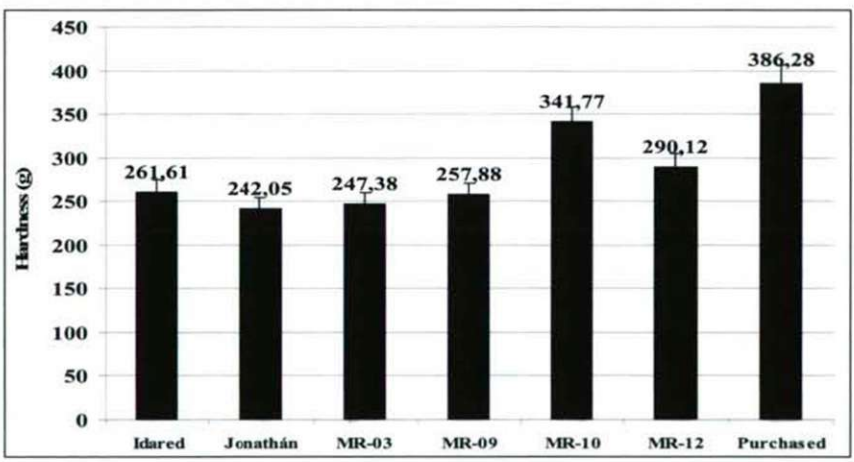

Figure 6. Hardness values of samples pre-treated citric acid

Adhesion is the work necessary to overcome the attractive forces between the surface of the food and the surface of the material with which the food comes into contact (e.g. tongue, teeth, and palate). Work required pulling food away from a surface.
Adhesion values of samples pre-treated by citric acid are shown in Fig.6.

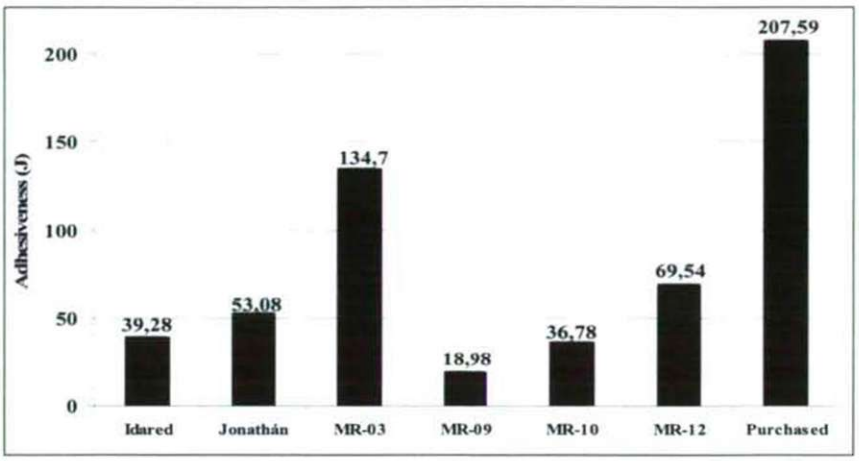

Figure 7. Adhesion values of samples pre-treated by citric acid

4. CONCLUSION

Food industry has continuous development. Costumers like choose healthier foodstuffs, rich in vitamins, antioxidants, fibre, and request without food additives. Very important to breed new apple candidates which are resistant against fruit diseases. They are promising because of the smaller scale use of pesticides (environmental friend technology), and they have similar fruit quality to the commonly grown susceptible cultivars. The new candidates are characterized by good quality and excellent productivity.

Among the apple products dried apple slices have importance, because of the healthier, natural aspect.

In our work apple were dried without using Sulphur, ascorbic and citric acid were used to inhibit enzymatic browning. Dried slices were evaluated by colour and texture values, and sensory analysis. Consider of the sensorial results, the best one was variety Idared pre-treated ascorbic acid; second one was candidate MR-10 citric acid.

At the end of our work It can be state without using sulphur in drying technology it can be produce dried apple chips with good quality and convenient colour from new multiresistant apple candidates and commercially varieties also.

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